GINSENG (*Panax quinquefolius* L.) CULTURE IN MARATHON COUNTY, WISCONSIN: HISTORICAL GROWTH, DISTRIBUTION, AND SOILS INVENTORY

by
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A Thesis
Submitted in partial fulfillment of the
requirements for the degree
MASTER OF SCIENCE

College of Natural Resources

UNIVERSITY OF WISCONSIN
Stevens Point, Wisconsin

May, 1982

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ABSTRACT

Knowledge of ginseng (Panax ginseng) and its medicinal importance to the Chinese culture can be traced back more than 4,000 years. Information on ginseng and its reported value to the Chinese spread to North America by written reports kept and passed along by missionaries. Soon after its discovery in North America, ginseng (Panax quinquefolius L.) became increasingly scarce as a result of overharvest and habitat destruction. This resultant decline in natural production encouraged many early attempts to cultivate this plant.

The cultivation of ginseng has flourished in Marathon County for the past eighty years. Presently, nearly ninety percent of the domestic production in North America is believed to occur in this county. The reasons for the prodigious success of this crop in the county are not entirely clear. It has been frequently suggested that the acidic nature of the soils, coupled with its excellent drainage characteristics, and the accompanying cool climate are the major factors contributing to the region's success. However, it would be shortsighted to attribute the success solely to these physical factors without recognizing the cultural components involved.

Ginseng is considered a minor and specialized crop in Wisconsin. Subsequently few public dollars have been available for research into the production of this plant. Prior to this study, basic data at the county level documenting current acreages, preferred soils, and the pattern of historical growth were unknown. Using aerial photography, it was possible to trace the culture's expansion from 250 acres in 1938 to nearly 1,100 acres in 1980. Many soil series throughout the county are

in use in growing ginseng. However, Marathon, Fenwood, Rozellville, Chetek, and Moberg soil series were predominately engaged in the production of ginseng in 1968, 1978, and 1980.

Cultivation practices commonly employed in the production of ginseng are unique to this crop. Four years of intensive labor is required from the time seeds are planted until the roots are harvested. Conscientious spray and hand weeding programs dominate the spring and summer activities. Fall is the busy season with seed harvest, seed bed preparation-planting, and root harvest all following at close intervals.

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ACKNOWLEDGEMENTS

I wish to acknowledge and thank the many people in Marathon County who have assisted me in this project. These include: William Fiala, George Hartman, Ferdinand Ollhoff, and their supporting staffs. In addition, I thank Paul Hsu, Don Volhard, Ruben Krueger and sons, Walter Hornung, Roy Schultz, and other ginseng growers for providing technical assistance.

My sincere appreciation and thanks is extended to Jay Cravens, Milo Harpstead, and Irvin Korth for their critical review and comments. I give special thanks to Clarence Milfred for his criticism, editing assistance, and continued encouragement throughout this study.

I am especially grateful to my father, Adolph, who has been a subtle, but motivating force throughout this project.

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I. INTRODUCTION

For centuries, the root of the ginseng plant has been highly regarded by Far Eastern cultures for its tonic and medicinal effects. It was the value which the Orient placed on ginseng root that led to the development of an extensive ginseng trade between colonial America and China. American trade with China lasted until a change in Chinese government in 1948 caused American exportation of goods to China to cease. American ginseng has been exported primarily to Hong Kong since that time.

Early exports of ginseng were derived wholly from plants of wild origin. Overharvesting and the destruction of natural habitat have reduced current U.S. exports of wild ginseng to one-fifth the amount exported annually in the early 1800's. In response to the decline of native populations of ginseng and a simultaneous increase in its value as an export, attempts at commercial cultivation of ginseng were initiated in the mid 1800's. It was not until 1908, however, that the first cultivated ginseng from Wisconsin and New York entered the export market. Since then the proportion of commercially grown ginseng has steadily increased and has surpassed the amount of wild ginseng exported.

Wisconsin (Marathon County) is the major producer of cultivated ginseng in North America (Figure 1-A). Estimates for 1979 placed ginseng production (both cultivated and wild) at 440,000 pounds, (Patty, 1979). Exports of ginseng were estimated at 370,000 pounds and valued at 27.5 million dollars. Of the 370,000 pounds, 300,000 were cultivated and the rest was of wild origin. Approximately 90 percent, 275,000 of the 300,000 pounds of cultivated ginseng were grown in Marathon County (Nutrition, 1979). Total annual harvest for 1980 has been estimated at

550,000 pounds, (USDA, 1980). Between 300,000 to 340,000 of this was cultivated in Marathon County having a value of 25 million dollars, (pers. comm., Paul Hsu - Exporter). By comparison, the value of exported ginseng is about half the value Wisconsin receives for all its exported dairy products, (Bjorklund, 1981).

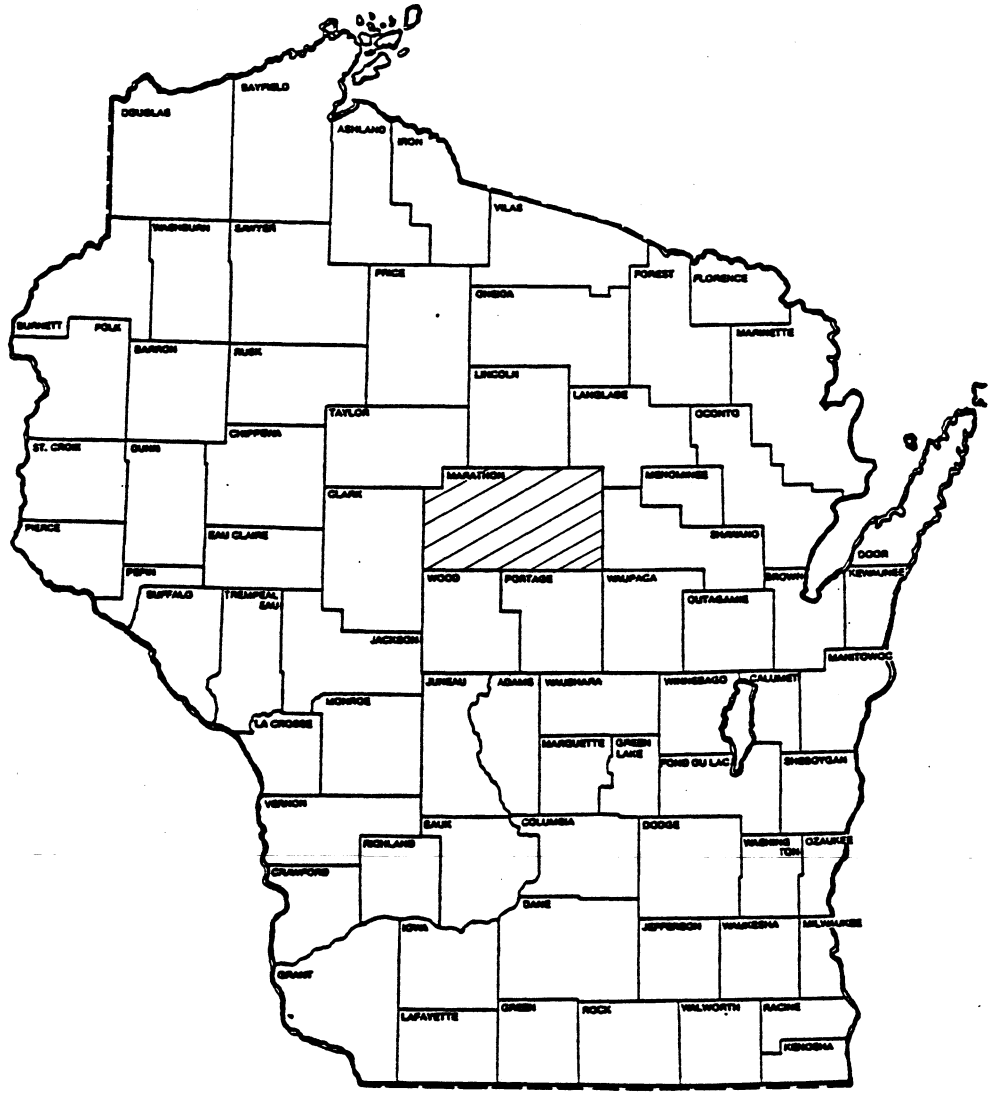


FIGURE 1-A: LOCATION OF MARATHON COUNTY (T26N-T30N, R2E-10E) RELATIVE TO THE STATE OF WISCONSIN

CURRENT STATUS OF WILD GINSENG PRODUCTION AND HARVEST

Wild American ginseng (Panax quinquefolius) has been harvested and exported from the United States since the 18th century. As early as 1905, concern was expressed that significant harvests of wild populations would soon become impossible because of indiscriminate harvesting practices, (Root, 1905). However, environmental conservation was only a dawning concern in the American consciousness at this time, and consequently no action was taken to protect diminishing ginseng populations.

In 1973, the treaty of the Convention of International Trade in Endangered Species of Fauna and Flora (CITIES) was ratified by several countries, including the United States. The purpose of this treaty was to protect animal and plant species whose numbers had been reduced to dangerously low levels. Appendix II of the CITIES treaty recognized wild American ginseng as a species that could be threatened with extinction if commerical trade of the plant were left unrestricted. As a result, trade in wild ginseng is currently highly regulated. The Endangered Species Scientific Authority (ESSA), and the United States Fish and Wildlife Service are responsible for overseeing the CITIES treaty in the United States. These agencies receive periodic information regarding the status of wild ginseng from each state in which it is known to grow (Jachowski, 1980). In 1977, ESSA banned export of wild ginseng root from the United States, due to their belief that after more than two hundred years of harvesting, wild ginseng had become dangerously rare in the United States, (Carpenter, 1980). ESSA felt that the plant deserved the status of "threatened", which precludes its exportation abroad. ESSA now requires that each state

must have a working management plan in place for wild ginseng, or be conducting research to develop a suitable management strategy, before export of the plant is allowed from the state. In response to this requirement, the Wisconsin Legislature passed Assembly Bill 108 in February of 1980, which allows the harvest of wild ginseng only during the period from August 15th to November 1st of each year.

THESIS JUSTIFICATION

Most protective steps taken by Wisconsin and other states in which wild ginseng is known to grow, are the result of highly subjective decisions since little is known about wild population counts or harvest levels. Carpenter (1980) states in her thesis that "there are still many local (wild) populations in Wisconsin, but changes in population structure have already been noted by most diggers. Local extinctions have also occurred in the state and there is no evidence that these trends are reversible, given continued harvesting and the continuing destruction of wooded habitat."

Increased production of cultivated ginseng may help reduce the demand for wild ginseng and lessen the threat of over-exploitation. Ginseng culture has flourished in Marathon County, Wisconsin, since the turn of the century and presently, nearly ninety percent of the domestic ginseng production in North America takes places in this county (Hartman, 1979).

At the present time there is little available information on cultivated ginseng. The United States Department of Agriculture (USDA) does not maintain official statistics on this crop and 1954 was the last year in which the Census of Agriculture included ginseng, (USDA, 1975). Figures generated by the USDA, county officials and others, regarding ginseng cultivation are at best rough approximations. An

example of data scarcity can be seen at the county (Marathon) level. Basic data on acreage, field distribution, and the number of people engaged in cultivation are not available. Not surprisingly, specific information relating to chemical, biological, and physical properties of soil on which ginseng is grown is also lacking.

An immediate need exists for the registration of pesticides with the U.S. Environmental Protection Agency (EPA) that demonstrates effectiveness in controlling ginseng pests and diseases. Acreage information is necessary to estimate the present economic value and would enable government agencies and chemical manufacturers to estimate the cost-benefit ratio of obtaining pesticide approval by EPA. Data on soils, acreage, and growth trends could be valuable to both growers and buyers in predicting future supplies of cultivated ginseng. Perhaps the greatest need for research is in solving how soils can be successfully "rehabilitated" to grow successive plantings of ginseng.

In response to this need for data, it is the intent of this thesis to begin a compilation of basic information and statistics on cultivated ginseng in Marathon County. This thesis has the following objectives:

1) To review literature on ginseng, its taxonomy, utilization, and commercial production.

2) To trace the historical progression of growth trends in the ginseng culture of Marathon County, noting the changes that have occurred through time and identifying practices unique to individual growers.

3) To summarize available information on ginseng research that has been conducted in the past as well as that currently in progress.

4) To determine the areal distribution of cultivated ginseng and the total acreage currently involved in ginseng production in Marathon County, WI.

5) To identify soils most commonly employed in growing ginseng.

6) To identify common concerns of growers and to suggest areas for future research.

II. LITERATURE REVIEW

Plant Description:

American ginseng, Panax quinquefolius L. is a perennial herb which occurs naturally in hardwood forests in the eastern half of North America, and has been field-cultivated for nearly 100 years in the U.S. and Canada. M. G. Kains (1912) describes the ginseng seedling at emergence as having two cotyledons which closely resemble that of a newly sprouted bean. Between the cotyledons is a small stem supporting up to three tiny leaves. Within 4-5 weeks these leaves are fully developed and the seedling has reached a height of 2-5 inches. After the first season, the plant develops a solitary bud at the crown of the root and it is from this bud that stems and leaves will develop in succeeding years.

In the second year, the plant grows to five or more inches and produces 1-3 branch-like stems. Each stem usually bears five leaflets (Figure 2-A). In the third and subsequent years, ginseng can have as many as five stems, each bearing five leaflets, and reaching an overall height of 18-24 inches (Figure 2-B). The two smallest leaflets on a stem are less than two inches long and the larger leaflets average 3-4 inches in length. The leaf margins are saw-toothed and end in a sharp point. For the most part the flower stalk forms on plants that are at least three years old (Figure 2-B and 2-C) and is borne erect in an umbel, and are described by Kains (1912) as being inconspicuous, odorless, yellowish green flowers. By August between 30-40 green colored berries form and change to a bright crimson color in early September when the fruit has ripened. Each berry contains from 1-3 wrinkled seeds that are about the size of small wax beans.

The root, which is the part having commercial importance, is composed of three parts (Figure 2-D): 1) root stock; 2) main body; and 3) rootlets or fibers. Young roots are linear shaped and generally light in color. As the root grows older, the color often darkens and the root may become forked with many rootlet fibers extending from the main body. The size of the root over time is influenced by the supply of food available and other environmental conditions. Yearling roots are usually between 1/8-1/4 inch in diameter. More mature roots (4-5 years of age) are spindle shaped, 2-4 inches in length, and grow to about one inch in diameter.

FIGURE 2-A: TWO YEAR OLD GINSENG SEEDLING

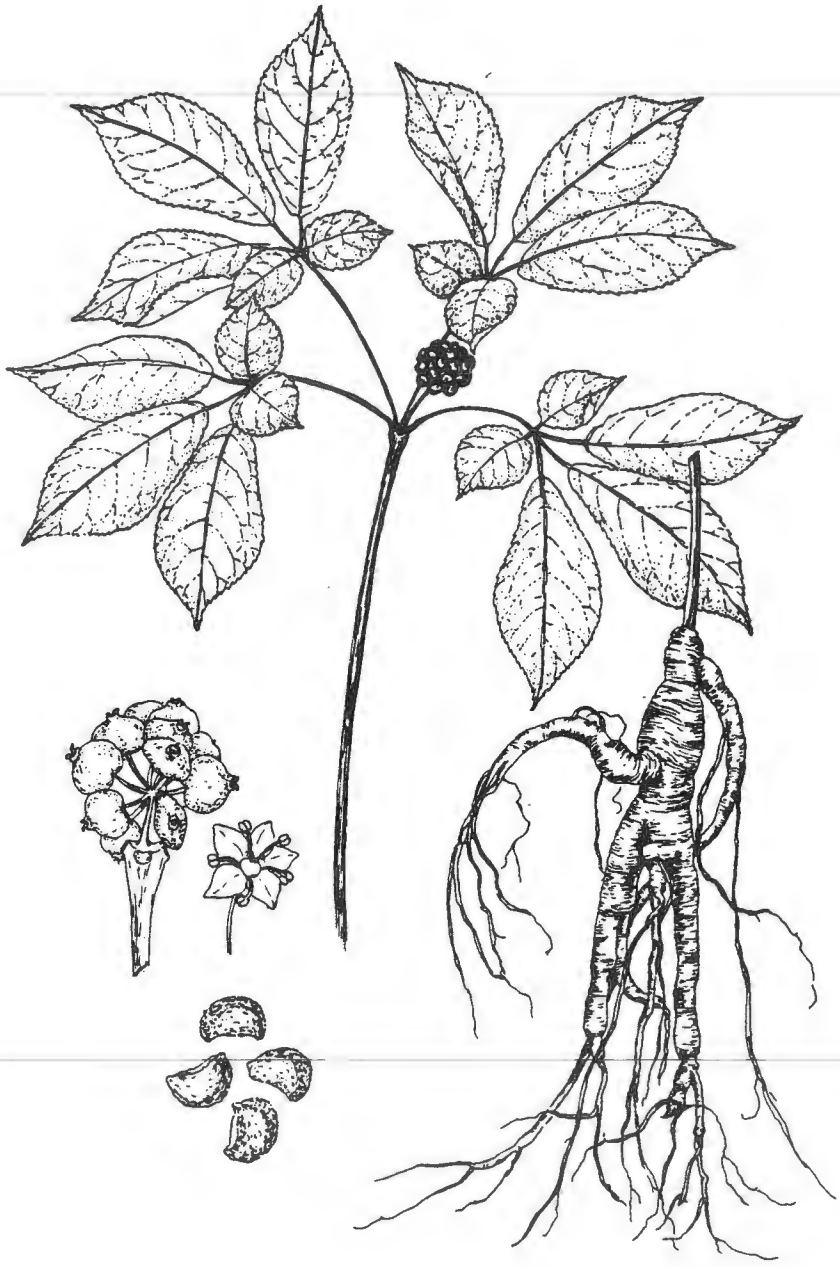
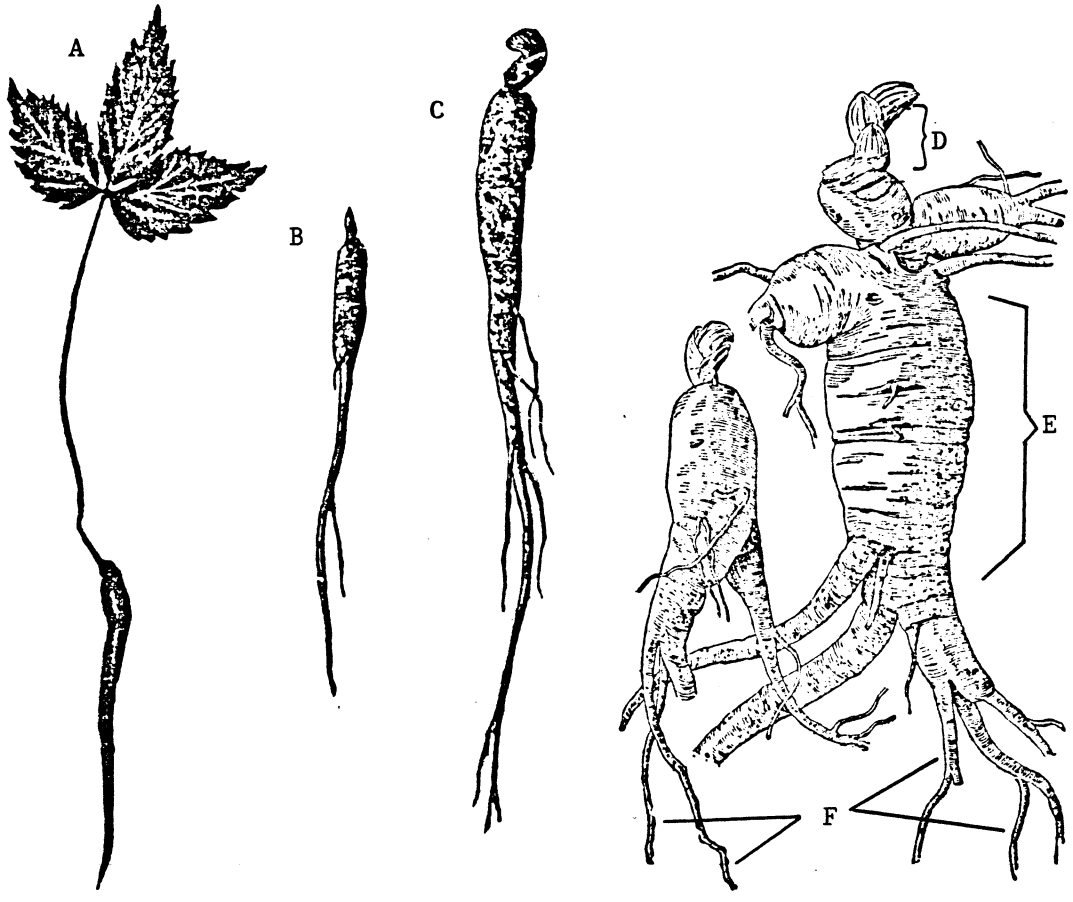


FIGURE 2-B: BRANCH, ROOT, FLOWER, BERRIES, AND SEEDS OF PANAX QUINQUEFOLIUS L. (DUKE AND WILLIAMS, 1978)

FIGURE 2-C: 4 YEAR OLD GINSENG PLANT WITH SEED CLUSTER



A = Yearling Ginseng Seedling & Root
B = Yearling Ginseng Root
C = Two-Year-Old Root
D = Root Stock & Bud
E = Main Root Body
F = Root Fibers (Rootlets)

FIGURE 2-D: PANAX QUINQUEFOLIUS L. ROOTS (KAINS, 1912)

TAXONOMY AND NATIVE HABITAT:

". . . if (ginseng) is to be found in any other country in the world, it may be particularly in Canada, where the forests and mountains, according to the relation of those that have lived there very much resembles these here."

-- Jartoux, 1711-China (Carpenter, 1980).

Ginseng belongs to a genus in the Araliaceae family that has approximately 70 genera and 700 species. This family is closely related to the parsley family which includes the parsnip, carrot, and celery. Although the name ginseng is properly used only in reference to plants of the genus Panax, many plants representing a number of genera and classified in unrelated botanical families have been inappropriately labeled with common names like "seng" or "ginseng". This is largely due to the fact that a variety of plants possess tonic-like properties similar to those of true ginseng (Foster, ____).

Two better known trade species of ginseng are of Asian and North American origin. The technical name for Chinese or Korean ginseng, Panax ginseng, is derived from the Greek word panakos (pan-all) akenis thae (akos) or commonly referred to meaning panacea, a remedy for the health of all people (Harris, 1978). Depending on the taxonomic treatment, (Hara, 1970; Hu 1976 and 1978; Lewis, 1979; and Staba, J. E. and Chen, S., 1979) the number of Asian species of ginseng varies from five to as many as eleven (Table 2-A). The best known Asian species are: Panax ginseng C.A. Meyer (oriental ginseng); Panax pseudo-ginseng; and Panax zingiberenis (ginger ginseng). All three are similar to the North American species.

Table 2-A PANAX SPECIES (Staba et. al., 1979)

BOTANICAL NAME	SYNONYMS	GEOGRAPHICAL SOURCE
1) Panax quinquefolius Linnaeus (1753)	American Ginseng, Canadian Ginseng, Sang	North America
2) Panax trifolius Linnaeus (1753)	Dwarf Ginseng, Ground-Nut	North America
3) Panax ginseng C. A. Meyer (1843)	Oriental Ginseng	North China, Korea, Manchuria, North Japan
4) Panax pseudo-ginseng Wall		
var. notoginseng (Burkill) Hoo and Tseng	Sanchi Ginseng	China
var. wangianus (Sun) Hoo and Tseng	----------	China
var. elegantior (Burkill) Hoo and Tseng	----------	China
subsp. japonicus (Nees) Hara (1970)	Chikusetsuninjin Japanese Ginseng	Japan
subsp. himalaicus (Nees) Hara (1970)	----------	Central and Eastern Himalaya, Bhuan, Tibet, West China
5) Panax assamicus Banerjee (1968)	----------	Eastern Himalaya
6) Panax sikkimensis Banerjee (1968) Himalaya	----------	Sikkum

Table 2-A Cont.

Panax Species (Lewis, 1979 and Foster, ____).	Panax Species (Hu, 1976)
1) Panax ginseng (oriental, Chinese, or Korean Ginseng)	1) Panax ginseng
2) Panax pseudo-ginseng (san-chi ginseng)	2) Panax pseudo-ginseng
3) Panax japonicum (Japanese or bamboo ginseng)	3) Panax japonicum
4) Panax quinquefolius (American or Canadian ginseng)	4) Panax quinquefolius
5) Panax trifolium (dwarf ginseng)	5) Panax bipennatifidum Seem (Feather Leaf Bamboo ginseng)
	6) Panax major Burk (Big leaf Sanchi)

The distribution of these species in Asia is greatly reduced from what it was several centuries ago because of the heavy demand for wild roots to be used in medicines. For example, in historic times the highly prized P. ginseng ranged from Korea into central China and Siberia - between 39 and 47 degrees north latitude, and 126 and 136 degrees east longitude (Figure 2-E). At present its range is reduced to localities in northeastern China and Korea.

Two species of the family Araliaceae, Panax quinquefolius L. and Panax trifolius (dwarf ginseng) are the only North American species of ginseng. Although little has been published on the ecology of P. quinquefolius L., what is known indicates that it is ecologically similar to P. ginseng. P. quinquefolius L. was originally found in 1716 at the same range of latitude, and in a mesic deciduous forest similar to the forests where P. ginseng had been found in northwestern China (Nash, 1895). The natural range of P. quinquefolius closely parallels that of the North American eastern deciduous forest (Figure 2-F).

P. quinquefolius L. and the Chinese species P. ginseng C. A. Meyer are morphologically similar to one another and the differences between them are minor. Graham (1966) states that the differences occurs in the angle between the leaflet base and petiole, persistence of membranous or fleshy bud scales at the base of the stem, and difference in peduncle length. Chemical analysis has shown that both species have very similar chemical properties. Chinese pharmacologists admit that any difference between the two is largely in the mind of the user, even though they continue to sell the Chinese variety at higher prices (Harding, 1972).

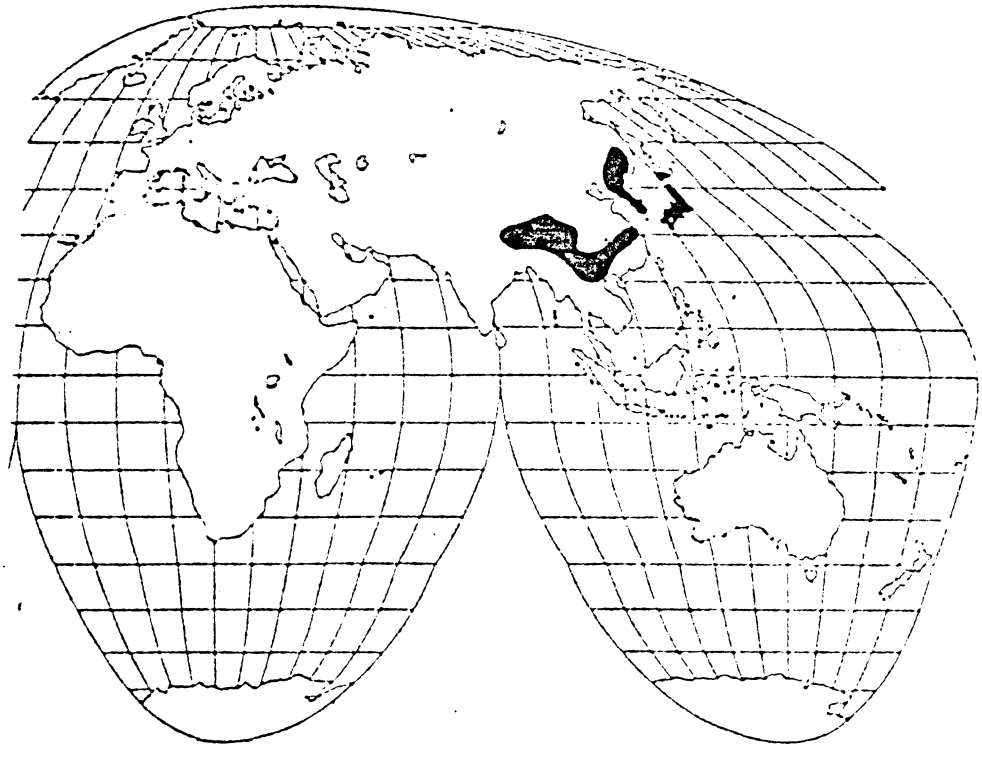


Figure 2-E: Historical Range of Panax ginseng (Lewis, 1979)

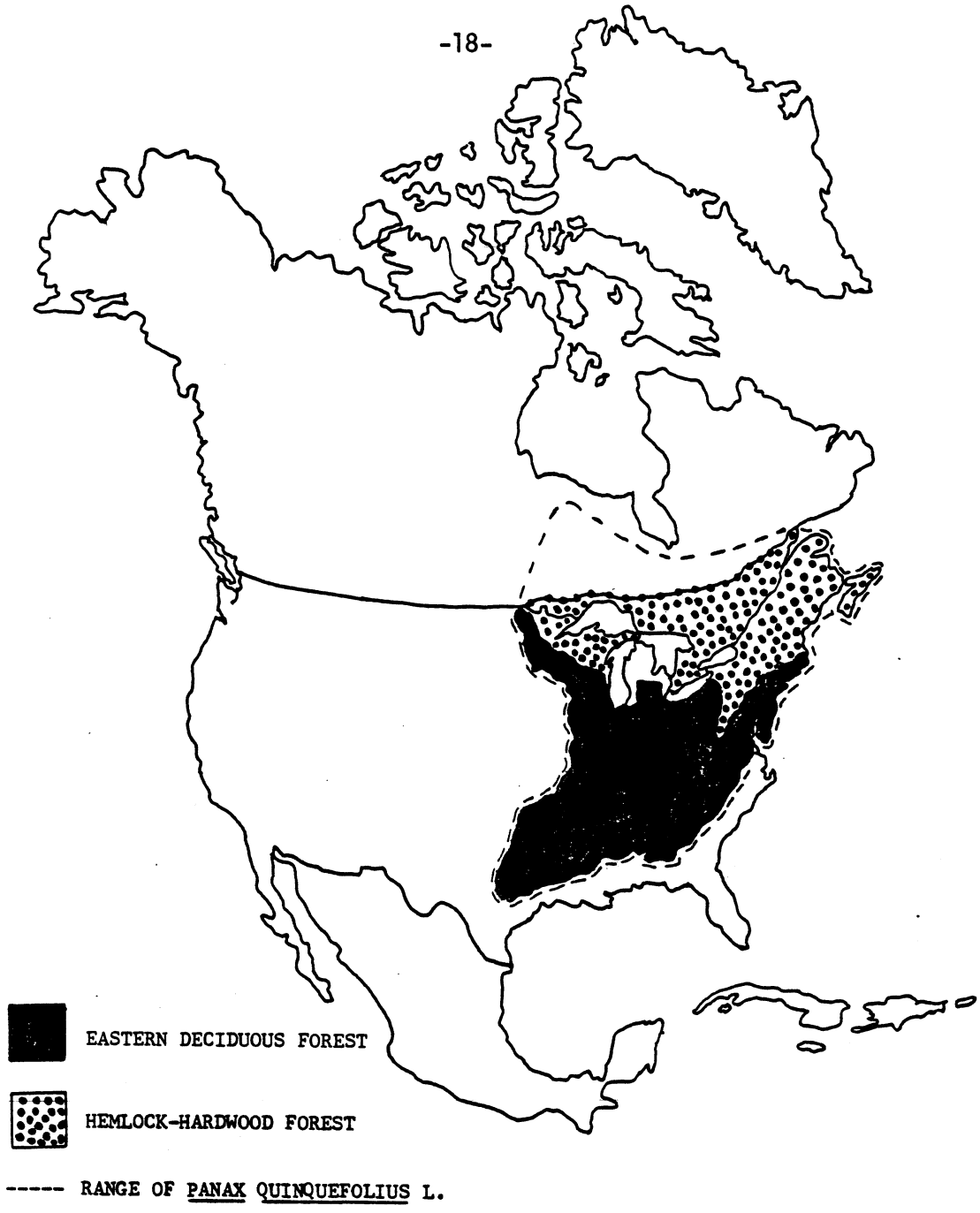


Figure 2-F: Historical Range of Panax quinquefolius (Heffern, 1976), Eastern Deciduous Hardwoods, and Hemlock Forests, (McCormick, 1959).

Within the genus Panax, P. ginseng, P. quinquefolius, and P. pseudo-ginseng all contain sapogenins of the dammarine group. P. trifolius and P. japonicus contain acid sapogenins of the oleanans group. The former three species have been preferred for medicinal use and trade for thousands of years (Staba, J. E. and Chen, S., 1979). Each of the aforementioned chemical groups has a specific effect on the human body. In general, ginseng is considered to have tonic, stimulant, diuretic, and carminative properties. It lowers the blood sugar level, and acts favorably on the metabolism, central nervous system and on endocrine secretion (Baranov, 1966).

UTILIZATION

The medicinal use of ginseng root can be traced back to China over 4,000 years ago. Confucius is said to have acknowledged ginseng's great healing powers as early as 2500 B.C. (USDA, 1974). The earliest known written mention of ginseng is found in a Chinese herbal of the First Century B.C. (Baranov, 1966). The Chinese have long considered ginseng to be a sovereign remedy and have placed special emphasis on its virtue as an aphrodiasiac. It is believed that ginseng was used in 16th century France as a treatment for asthma, stomach disorders, and to promote fertility in women, (Schorger, 1969).

Medicinal attitudes of the Orient tend to perpetuate the age-old knowledge surrounding the use of natural plant and animal derived products in their medicines as opposed to products of synthetic origin. An important characteristic of these cultures is the use of composite prescriptions, containing several constituents of vegetable, mineral, and animal origin. Drugs administered by eastern practitioners are generally of low toxicity and are taken orally in comparatively large doses. The drugs are not known to produce a quick symptomatic effect, but instead work slowly while increasing the patient's natural resistance to sickness and disease, (Brekhman and Dardymor, 1969). Experimental and clinical investigations by Russians, Germans, Chinese, and other authorities have shown a wide range of pharmacological and remedial efficacy of ginseng. Investigations have found ginseng to contain six glycosides called panaxoxides and six sapagenins attached to the glycosides which in combination: increase endocrine activity, mildly increase metabolic rate, mildly stimulate the circulatory system and the digestive properties, maintain the

general equilibrium of the body, and prevent adverse reactions to stress. Ginseng is also known to contain the following minerals: phosphorous, iron, copper, magnesium, potassium, sulfur, manganese, silica, and sodium. The enzymes amylase and phenolase are present in ginseng, which also is rich in vitamins B-1 and B-2, (Ziglar, 1979).

Ginseng has long been considered by eastern cultures to be somewhat of a panacea. By definition a panacea is a universal remedy with an ability to cure all diseases, (Harris, 1978). Many of the medicinal claims of ginseng as a cure-all are the results of its adaptogenic effect. Brekhman, et al, (1969) an eminent Soviet physiologist describe adaptogens as medicines which increase all-around resistance and strengthen the entire body. Traditionally, ginseng has been used in the orient to stimulate the mental and physical capacity for work, curing neurosis, hypotension and some forms of hypertension, (Brekhman, et al, 1969). Harris (1978) and Ziglar (1979) report that the Chinese use ginseng to improve blood circulation, control hemorrhages, and it is also known for its anti-rheumatic benefits.

Since the discovery of ginseng in North America in 1716, Americans have largely been interested in ginseng's economic value as a cash crop for export. A report published by the USDA (1978) estimated that 95% of all ginseng harvested in the United States is exported.

Ginseng is one of many unique medicinal herbs that is difficult to classify under present categories in the United States. By broad definition it is both a food and a drug. The Food and Drug Administration (FDA) has been reluctant to classify ginseng as a drug since there has been no major research by American authorities

verifying its therapeutic claims. The FDA has classified ginseng as a food additive under the "Grandfather clause" which applies to those herbs with a history of long standing public use prior to the enactment of the Food Additives Amendment of 1958, (Ziglar, 1979). Therefore, ginseng that is marketed in the U.S. in either a tea, powder, or other form is sold as a food additive, and not as a drug. Corr, (1979) states that with closer investigations by the American Medical Association, ginseng may be reclassified as a drug, and subsequently take on a new meaning in this country. At present, ginseng in the United States is found primarily in natural health food stores and within cultural enclaves such as China Towns in San Francisco, Chicago, and New York. In the United States, health conscious individuals use ginseng much the same ways as the Chinese. However, American entrepreneurs have utilized ginseng in the cosmetic and soft drink beverage industries as well.

History of Ginseng

Early Jesuit missionaries are credited with being the first representatives of western society to observe and evaluate the importance of ginseng in Chinese culture. It was through their written accounts and meticulous drawings describing the plant that knowledge of ginseng spread. By the beginning of the 17th century, most of what was known about ginseng in the western world came from the observations and written accounts of Father Jartoux, a missionary in China during this time (Dixon, 1976; Harris, 1978; and Heffern, 1976). Jartoux's fascination with the Chinese use of the plant caused him to ponder where ginseng might be found elsewhere in the world. He reasoned that Canada would be the most logical place because the climate, mountains, and forest vegetation were similar to those of China.

Jartoux's accounts were passed along and read by missionaries in other countries. Father Lafitau, a Jesuit missionary among the Iroquois Indians at Sault Ste Louis, Canada, read these accounts and soon afterward discovered ginseng growing in abundance near Montreal in 1716 (Kains, 1912; Schorger, 1969 and Staba, 1979). Ginseng was used and known by the Iroquois as "Garantoquen" meaning "man-like" (Harris, 1978), which referred to the often anthropomorphic appearance of the root.

The discovery and development of commercial ginseng trade in Canada has been likened to that of gold in California and Australia. After its discovery, the French became aware of its value to the Chinese and began enlisting Canadian Indians to dig all they could find. Trade with China developed and flourished until 1752. In that year demand, and the price the Chinese were willing to pay reached an

all time high. This was an incentive for the French to dig all the root they could find. Large quantities of root were collected without regard for size or age. After it was improperly dried in ovens, the quality of the root was so inferior that the Chinese refused to buy it. Subsequently, trade with China was reduced from $100,000 in 1752 to $6,500 in 1754 and soon ceased entirely (Nash, 1895; Root, 1905; Kains, 1912; Nat. Hist., 1948; and Hou, 1978). It was nearly a century later before the reputation of North American ginseng was restored and trade with China was re-established.

Around the time China severed trade with Canada, the fame of ginseng had spread to the American colonies. In 1750 wild ginseng was discovered in western New England, and a year later in central New York, Massachusetts, and Vermont. As the colonies expanded to the west and south, ginseng was found to occur throughout the region previously shown on Figure 2-F. From the beginning, trade in ginseng, colloquially called "sang", was largely in the hands of fur traders. The port of Philadelphia remained the principal site of ginseng export for many years. Some ginseng was being exported to England and in 1752 it was hoped by the merchants of Philadelphia that a permanent market for ginseng could be created in England. This hope never materialized and by 1772 ginseng was no longer exported to England (Schorger, 1969). It is reported that John Jacob Aster from the American Fur Company made the first shipment of American ginseng to China in 1782, (Schorger, 1969). Large amounts of ginseng were purchased by Daniel Boone in Kentucky, and in 1802 ginseng was the only product that could bear the cost of transportation overland to Philadelphia.

Wild ginseng was reported to be widespread in Wisconsin prior to settlement, and was used medicinally by several Indian tribes. The early settlers in Wisconsin harvested wild ginseng at rates much higher than are realized today. By 1845 Green County, Wisconsin had acquired the nickname of "Sang County" (Hou, 1978). Modest fortunes were being made in other Wisconsin Counties soon after the discovery of ginseng: 1847, Sauk County; 1854, Vernon County; 1859, Pierce County; 1860, Dunn County; and 1864, Menomonie County (Schorger, 1969). By the 1860's, Minnesota and Wisconsin were exporting large quantities of ginseng to China. Kluether and Lorence (1977) state that the discovery of ginseng in Marathon County occurred in 1877.

Statistics on the early trade of Wisconsin ginseng are very sparse. It is known, however, that the state's exports to China were valued at $40,000 in 1858, and one year later this amount doubled (Nash, 1895, and Hou, 1978).

Wild ginseng became increasingly scarce by the mid to late 1800's, due to 1) overharvesting and harvesting of plants before their seeds matured, thus depriving plants of their only means of self-perpetuation, 2) habitat destruction from intense cutting of hardwood forests, and 3) trampling by livestock pastured in forests. This decline in natural production encouraged many Americans to cultivate ginseng, as the Japanese and Koreans had been doing for 200 years (Whetzel, 1912). At first failure was so common that it was generally believed impossible. In the 1870's Abraham Whisman of Virginia became the first to successfully cultivate ginseng, (Williams, 1957). However, George Stanton of New York is recognized as the first

commerical grower in the United States. Stanton's first garden, 43 feet by 3 feet, produced 570 roots, many of which were small and subsequently replanted. However, the garden yielded 5 pounds of mature roots that sold for $16.83 (Stanton, 1892). Later, an 85 square foot garden reportedly produced 106 pounds of dried roots and sold for $575.00 (Nash, 1895; Dixon, 1976; and Hou, 1978).

Between 1880 and 1903 ginseng farms mushroomed throughout the eastern and midwestern states. This period is often referred to as the "Ginseng Boom" which ended in 1904 when a serious outbreak of Alternaria Blight occurred (Hou, 1978). Many new and inexperienced growers became discouraged after most of their seed crop was destroyed and consequently, many did not replant. According to the 1909 Census of Agriculture (Table 2-B) only 23 acres of ginseng were under cultivation in the United States. By 1929 cultivated acreage increased to 434 acres, but within a few years the total acreage declined drastically (USDA, 1979).

TABLE 2-B UNITED STATES: GINSENG CULTIVATION 1902-1954
(USDA, 1979)

YEAR	FARMS REPORTING	AREA	YIELD	PRODUCTION
	Farms	Acres	Pounds per acre	1,000 pounds
1902	(1)	20	(1)	(1)
1909	(1)	23	(1)	(1)
1919	(1)	54	344	18.6
1929	303	434	137	59.3
1949	19	12	833	10.6
1954	5	21	4,219	88.6

[1] Not available.

Note: Reliability of the data cannot be guaranteed in cases where few farms are involved. After 1954, ginseng was no longer shown as a separate item in Census questionnaires, - U.S. Bureau of the Census.

The drop in acreage that occurred between 1929-1949 is attributed to the Sino-Japanese War and World War II, which eventually halted American trade with China in 1948. After 1950 demand for American ginseng increased when communication and trade relations were re-established with the Far East. However, ginseng was then shipped to Hong Kong instead of China (Pinkerton, 1974; Kluether and Lorence, 1977; and Hou, 1978).

The United States' production of dried ginseng root has increased from an average of 72 metric tons in 1960-1962, to 90 metric tons in 1971-1973 (USDA, 1974) to an estimated 200 metric tons in 1978-1979. In 1978, of the estimated 200 metric tons (metric ton = 2,205 lbs.) produced in the U.S., 180 metric tons were exported, making U.S. the second largest exporter and the third largest producer. For comparison purposes, world production of ginseng in 1978 was estimated at 3,500 metric tons. South Korea was by far the leading producer with 2,300 metric tons and the leading exporter, exporting 1,600 metric tons. The People's Republic of China had an output of 600 metric tons. Japan is ranked next to the U.S. with production of around 125 metric tons (Patty, 1979).

Official statistics are not available on the proportion of the U.S. crop that is gathered from the wild, although estimates by the USDA indicate that about three quarters of the U.S. production in the marketing year of 1975-1976 was cultivated ginseng. However, wild ginseng may have accounted for between 40-45 percent of the total value of ginseng exported, since wild ginseng commands a much higher price (Table 2-C), (Patty, 1979).

TABLE 2-C: WILD vs. CULTIVATED GINSENG PRICES
(pers. comm. Pulvermacher and Hsu)

Pulvermacher's Ginseng (Richland Center, WI)			Average Price/lb.	Karlen's Ginseng Co. (Wausau, WI)		
YEAR	WILD	CULTIVATED		YEAR	WILD	CULTIVATED
1975	$85-100	$28-33	Price depends on: -Root quality.	1975	$60-80	$24-32
1976	$100-115	$30-35	-Time of year sold.	1976	$96-120	$32-40
1977	$115-125	$35-40	-Economy and politics of importing countries	1977	$114-150	$38-50
1978	$125-140	$40-56	-Presence of middle man -Availability of root.	1978	$132-150	$44-50
1979	135-145	$35-45		1979	$111-126	$32-42
				1980	$110-130	$45-72
				1981	$110-130	$48-68

A study of Table 2-D shows that the demand as well as the price paid for American ginseng increased constantly from about 1964. In 1972, a boom in ginseng sales in Hong Kong occurred as a result of Richard Nixon's visit to China. Ginseng was also one of the products promoted on the 1979 trade mission to Japan, Taiwan, and South Korea, led by Wisconsin Governor Lee S. Dreyfus. In November, 1981 Dreyfus led a similar mission to China with hopes of securing additional markets for Wisconsin products. However, these recent visits are not expected to duplicate the "Boom of 72", (Pers. Comm. Paul Hsu).

Fluctuations in the ginseng market are directly related to the economy and politics of the Orient. For example, the market in 1979 was down 20-25 percent (Table 2-D) from 1978. This market condition was partially attributed to the change in U.S. relations with Taiwan and reinstituting trade with mainland China, (Hanousek, 1979). New York exporter Tat Kong cautioned that new trade relations with China may not significantly affect the demand for American ginseng. He reasoned that most Chinese are poor and do not have the money to purchase such "luxuries" as ginseng, (pers. comm. Tat Kong).

TABLE 2-D: DOMESTIC WHOLESALE (AVERAGE) PRICE, EXPORTS, AND TOTAL VALUE OF AMERICAN GINSENG FROM 1821 TO 1979 (Root, 1905; Special Crops J., 1911; Hou, 1978; and USDA, March 1980)

YEAR	TOTAL EXPORTED (lbs.)	TOTAL VALUE ($$$)	AVERAGE PRICE/lb.
1821	352,992	171,786	$ .48
1823	385,877	150,976	.39
1845	468,530	177,146	.37
1858	366,053	193,736	.52
1862	630,712	408,590	.84
1868	370,066	380,454	1.02
1878	421,395	497,247	1.13
1888	308,365	657,358	2.13
1890	223,113	605,233	2.71
1898	174,063	836,466	3.66
1900	160,101	833,710	5.20
1905	146,576	1,069,849	7.30
1915	103,184	919,931	8.91
1916	256,082	1,597,508	6.23
1920	160,050	1,875,384	11.71
1925	138,131	1,668,221	12.07
1929	234,000	2,766,000	11.82
1930	203,000	1,877,000	9.24
1933	233,400	844,000	8.62
1934	232,000	1,203,000	5.23
1938	167,000	1,029,000	6.15
1964	139,206	2,731,602	19.62
1965	116,791	2,887,310	24.72
1966	173,405	4,358,542	25.13
1967	146,135	4,507,152	30.84
1968	133,701	4,359,524	32.61
1969	145,392	5,533,406	38.06
1970	162,689	5,016,951	30.83
1971	168,835	5,827,289	34.51
1972	227,549	8,922,426	39.21
1973	183,136	8,846,112	48.30
1976	330,750	17,910,000	54.15
1977	381,465	26,530,000	69.55
1978	396,900	24,552,000	61.86
1979	355,005	22,216,000	62.58

*Add 10% to the "TOTAL EXPORTED" column provides an estimate of the total U.S. Production - e.g. U.S. exports 90% of its total ginseng production.

WISCONSIN HISTORY OF GINSENG CULTIVATION

In literature dating back to 1895, George V. Nash (1895) made frequent reference to the commercial cultivation of ginseng occurring in New York, Kentucky, and North Carolina, but does not mention Wisconsin as being a commercial producer. It appears that cultivation of ginseng began in Wisconsin (Marathon County) just after the turn of the century, (Klueter and Lorence, 1977). Frank Volhard (Kluether, et. al., 1977), Reinhold Dietsch and the Fromm Brothers (Luedtke, 1972) were among the county's earliest cultivators. After studying the forest habitat in which ginseng grew naturally, these individuals were successful in collecting wild plants and transplanting them into small beds or "gardens" that simulated natural conditions. The Fromm's first plot measured 5'x16' and contained 150 plants (Pinkerton, 1974). Each fall these growers expanded the size of their plots by transplanting more forest plants, and by beginning new nursery stock from the seeds collected from previously transplanted plants. Between 1909 and 1913 three firms were engaged in managing large ginseng gardens: 1) the Chellis & Sampson Ginseng Co., had planted about 40,000 seeds and transplanted nearly 5,000 plants in 1909; 2) the Badger Ginseng Company, by 1913 had 5-1/2 acres of ginseng growing in the city of Wausau with capital stock worth $50,000; 3) The Wausau Ginseng Gardens, in 1913 had 3-3/4 acres under cultivation, valued at $35,000 (Marchetti, 1913). However, it appears that these enterprises were short lived as no further reference to these companies is found in the literature after 1913. Ginseng cultivation in Marathon County has been and continues to be carried on primarily by individual families. In

1919, the Fromm family became the county's largest producer of ginseng with 19 acres under cultivation (Marathon Times, 1919). By 1923 they were harvesting from 4-5 acres each year (roots are generally harvested after 4 or 5 years of growth). Today they are still recognized as the county's largest producer and perhaps the largest in North America.

Information that would permit a more complete account on Marathon County's ginseng culture does not exist. A letter dated July 10, 1980, from Carroll D. Spencer, Agricultural Statistician for the Wisconsin Agricultural Reporting Service (USDA), reaffirmed a previous statement made in the introductory section of this paper: ". . . the USDA does not estimate acreages, yields, production or value of cultivated ginseng in Wisconsin." For years, feature writers have focused numerous magazine and newspaper articles on individual family enterprises, but have contributed little to document the expansion of ginseng production in the county. A general understanding of the growth trends in the county may be acquired by using the figures on Table 2-D and extrapolating the contribution of Marathon County by using commonly accepted statistics, e.g. the county produces 90 percent of the ginseng cultivated in North America, yields range from 1,200-2,000 pounds per acre, etc. A more reliable method has been the use of aerial photography. The methods used in accomplishing this are discussed in the following chapter.

Cultivation

In 1870 the first successful attempt at cultivating ginseng was achieved by Abraham Whisman in Boones Path, Virginia. Between 1870 and 1895 20 gardens were reportedly started, primarily in the eastern half

of the United States (Williams, 1957). In 1895, the U.S. Department of Agriculture published a bulletin entitled, "American Ginseng, Its Commercial History, Protection, and Cultivation" (Nash, 1895). Demand for this bulletin was great enough to require revision and reprinting in 1898 and again in 1902. The Journal of Special Crops, published between 1902-1923, was devoted almost entirely to the cultivation of ginseng. Correspondence from growers, advertisements, and short essays by early researchers H. H. Whetzel, G. Stanton, J. Wilson, and others appeared in this publication.

George Stanton is considered the first "commercial" grower of ginseng (Stanton, 1892 & 1902). He reports on early research and discusses the importance of well-drained soils, techniques for seed stratification, seed bed preparation and seed planting. He reported that seeds planted in July or August had a better rate of germination than seeds sown in October or later.

Early Research on Diseases and Pests

A problem commonly resulting from the domestication and monoculture of any plant is the increased occurrence and concentration of disease within populations of that plant. Diseases of ginseng have been the subject of scientific research since Van Hook published the results of investigations carried out in New York State, (Van Hook, 1904). He reported that within little more than a decade of ginseng cultivation, diseases had become a serious problem in every ginseng growing area. Whetzel (1911b.) states, "it does not seem probable that the disease - Alternaria Blight was very common or destructive prior to 1904." Other diseases mentioned by Van Hook (1904), include a seedling end-rot characterized by a rotting away of the tap root, and Alternaria Leaf Spot. According to Whetzel (1911b.), Alternaria leaf spot is not the same disease as Alternaria Blight. Van Hook (1904) categorized the diseases as caused either by parasites or by environmental conditions. In most cases the cause of a disease is undetermined and only very meager descriptions are appended. He was first to report the sclerotial disease of ginseng roots, commonly known as black rot, but made no attempt to describe the life history or taxonomy of the causal fungus. Rankin (1912) identified the fungus Sclerotinia panacis Sp. as being responsible for the disease. He believed presence of this micro-organism in combination with a thin water film surrounding the root, and winter temperatures to be conditions favoring development of this disease.

H. H. Whetzel was perhaps the most widely known among early researchers of ginseng diseases and published reports of his research in Special Crops (Whetzel, 1907, 1909, 1911a., 1911b., and 1912). He

classified diseases as affecting either the portion of the plant above the soil surface, or the root. Whetzel described plant density, shade, drainage, and soil conditions as determinant factors in disease control. In several publications he focussed on Alternaria Blight which he described as "the most common, widespread, and best known disease of ginseng," (Whetzel, 1907, 1909, and 1911b.). In one study (Whetzel, 1911b.) the causes, symptoms, life history, and ecology of the disease are characterized. In this study and elsewhere, the dissemination and spread of diseases (Whetzel 1911a. and 1912) and early methods to control Alternaria Blight (Whetzel, 1907, 1909, and Whetzel, et. al. 1929) are also discussed.

Having investigated a widespread disease of older roots to which the name "rust" or "fiber-rot" has been ascribed, Whetzel and Rankin (1909), and Whetzel and Osher (1910) concluded that the disease was "but another form of the end-rot of seedlings." Whetzel and Rosenbaum (1912) reaffirmed this conclusion stating that "while the absolute proof of the common cause of these different symptoms on seedlings and other roots has not yet been established, the evidence thus far accumulated indicates that they are one and the same thing . . ." They also felt that available evidence indicated the fungus Thielavia basicola was the causal organism of the disease. Selby (1912); Brann (1916), and Whetzel et. al. (1916) prescribed formalin and steam treatments as soil sterilizers to eliminate parasitic organisms responsible for root rot diseases.

Prior to the work of Rosenbaum, et. al. (1915) and Zinssmeister (1918), the term rust had been applied more or less indiscriminately to diseases which, while generally resembling one another, were

undoubtedly caused by different organisms. Zinssmeister (1918) for the first time employed the term rust to indicate a specific root disease. Isolations made from material received from two widely separated states, New York and Wisconsin, most frequently yielded isolants of Ramularia, which later were resolved into two species, Ramularia destructans and Ramularia panacicola. Both species were found to be pathogenic on dormant roots and capable of establishing themselves during the dormant season.

Hildebrand (1935) describes two destructive diseases as being caused by several species of the genus Ramularia, and notes that these species appear able to persist in the soil indefinitely. Rotation combined with rigid sanitation practices were the only suggested methods for controlling the diseases.

Wilson and Runnel (1930, 1931, 1932a., 1932b., and 1933) spent several years researching Alternaria Blight and arrived at conclusions similar to those of Whetzel (1907, 1909, and 1911b.). They identified Alternaria panax as a disease causing organism, a parasitic fungus that depends on the ginseng plant for its food source and will subsequently kill it if left uncontrolled. Studies by both Rosenbaum (1915) and Zinssmeister, (1918) and Wetzel et al (1916) were first to observe that Alternaria panax also caused root rot in ginseng. Whereas earlier studies (prior to 1915) by Whetzel, Wilson, and Runnel failed to make this distinction.

According to Whetzel (1911a.) Alternaria panax only attacks ginseng and was introduced into many gardens when wild plants were transplanted. Wilson and Runnel experimented with different spray

solutions and dusting agents for controlling Alternaria Blight. After three years research, they concluded that copper-lime dust and copper sulfide powders were not effective in controlling this disease, (Wilson and Runnel, 1930, 1931, and 1932b.). When properly applied, however, four applications of a 3:3:50 (blue vitriol:lime:water) Bordeaux spray were 85-100 percent effective in reducing the proportion of diseased plants in check plots to two or three percent. Although these studies have shown the effectiveness of this chemical in controlling the disease, other studies have noted that injuries can accompany its use. Hendrick (1907) stated that, "the kind of weather following an application is one of the factors determining the extent of Bordeaux injury and the alternating periods of rain and bright sunshine are most conducive to injury." Whetzel (1907) reported on injury to ginseng resulting from the combination of Bordeaux spray and cold air temperatures. Wilson and Runnell (1931) found that plants not sprayed with Bordeaux solutions could usually survive low soil moisture and high evapo-transpiration rates resulting from high air temperatures. Under identical environmental conditions, however, plants sprayed with the Bordeaux mixture usually died because the film left by the spray apparently promoted an accelerated transpiration rate of the plants. High evapo-transpiration rates combined with low soil moisture content caused water loss by transpiration to exceed water uptake and plants reached the critical wilting point.

Modern (Recent) Research

Regulation of the environment, especially of soil humidity and aeration, and shade control are important factors in ginseng disease

control. Baranov (1966) discusses disease control by treating seeds with one of several fungicides, 1) a .25% solution of potassium permanganate, 2) 40% formaldehyde in concentration of 1:300, or 3) tetramethylthiuram disulfide. He agrees with Wilson and Runnel (1933) that spraying with the Bordeaux mixture according to the following schedule is an effective means of control: the first spraying when aerial shoots begin to appear in the spring; the second after the leaves of the plant are fully expanded; and the third 10-15 days after the second. Sanitation is another important means of disease control and Baranov, (1966) recommends that severely diseased plants should be eradicated while less severely diseased plants should have the infected parts removed.

University of Wisconsin Extension Agent George Hartman (1979) lists Alternaria Blight, phytophora root rot, and damping-off as the diseases most often encountered by Marathon County growers, and the Lygus Bug, root and foliar aphids, slugs, and leafhoppers as the more common insect pests. Hartman (1981) acknowledges that no pesticides are registered with the United States Environmental Protection Agency (EPA) for use on ginseng. As a result of this, and because established pest control practices are not consistent among growers, Hartman (1981) speaks only in generalities regarding the names, kinds and concentrations of pesticides commonly used by growers.

Since 1978, Entomologist Dr. Charles Koval and Plant Pathologist Dr. Craig Grau from the University of Wisconsin-Madison have been evaluating fungicide treatments for Alternaria Blight. In addition, they conducted limited experiments with chemicals that have

demonstrated efficacy against the pest problems of ginseng. Common pesticides with suggestions for controlling pest and disease problems are listed in Appendix B. Grau and Koval, along with Orlo Erhart of the Wisconsin Department of Agriculture have been working with growers to gain EPA approval for several of the pesticides listed in Appendix B.

Grau (1981) suggests three non-chemical means to help prevent Alternaria Blight disease: 1) The removal of dead plant debris at the peak of each growing season. This supports the observation by Whetzel, (1911a.) and Baranov, (1966) that plant materials harbor disease organisms over winter. 2) Plant densities maintained at levels to prevent overcrowding. This was also recognized by Proctor, (1980 and 1981) and Whetzel, (1912). 3) Location of gardens to encourage good air circulation. This was also stated by Baranov, (1966). Several chemicals researched by Grau (1981) for disease control are listed in Appendix B.

Donah Jenkins (1980), a Kentucky grower, reports using a mixture of 3 pounds Diathaine M-45, 2.5 pounds Captan 50, 2 pounds Sevin, and 1 quart Malathion to 120 gallons of water. He finds spraying every 10-14 days with this mixture takes care of "all" above ground diseases. Currie (1980) reports spraying young seedlings at the beginning of each growing season, using 3.5 pounds of Benlate to 500 gallons of water to control damping-off disease. A spray program using 12-15 pounds Diathaine M-45 per 500 gallons of water follows at 7-10 day intervals for the remainder of the growing season.

Gotlieb (1981) initiated a study to test the virtues of spring planting vs. fall planting in controlling damping-off fungi. He concluded that, "spring planting was a major factor in reducing root

disease incidence, increasing numbers of established plants, and increasing root length and weight." Gotlieb attributes the success to warmer spring soils which increase the vigor and rate of germination and results in seeds being less susceptible to soil borne pathogens. Application of Vydate (nematicide) prior to spring planting, and Vorlex (fungicide-nematicide) at the time of spring planting significantly increased root weight and length while it decreased disease severity when compared to spring planting alone without any pesticide applications. A major concern in Gotlieb's (1981) study was that seeds normally planted in the fall would germinate before Spring and require hand planting. Mechanical seeding was no longer possible since the radicals on germinated seed required delicate handling and would not pass through mechanical seeders.

Germination of ginseng seeds under natural conditions takes 18-22 months. Preliminary studies by Stoltz and Garland (1980) have demonstrated that an immature embryo within the endosperm is the primary condition restricting germination. Baranov (1966) reports that Soviet agriculturalists and botanists have developed a method to reduce this dormancy period to six months by treating seeds with a .05 or .1 percent gibberellic acid solution. This discovery has no apparent value to growers in Marathon County, Wisconsin, where seed stratification is used to overcome the dormancy of the seed. This method involves storing the seed for a 12 month period in layers of sand. Seed stratification is discussed more fully in the section on "Cultural Practices for Growing Ginseng." Stoltz and Garland (1980) state that "the methods of seed-propagation of ginseng are not well

described in popular literature available to potential growers." Most sources refer to stratifying the seed, but the time and temperature for stratification are not given and have not been investigated. Stoltz and Garland placed seeds indoors under five temperature conditions, 0, 5, 10, 20 and 30°C. Additionally, one lot was buried outdoors in soil 1-1/2" deep to simulate the conditions a seed might experience in nature. Measurements were made of the embryo, radicle and cotyledon at monthly intervals. It was found that embryo development occurred most rapidly and consistently at a constant temperature of 20°C. Konsler (1980) conducted similar research to examine the relationship of temperature and time in reducing the root-bud dormancy period. He found that one-year old roots stored at 2°C for 60 days or longer produced normal top growth when planted in nursery pots in a heated greenhouse. Time to emergence after planting was inversely proportional to time in storage.

Simulating the forest environment, wooden lath canopies have traditionally provided artificial shade for ginseng culture and more recently a woven, black polypropylene fabric has come into use. Proctor (1980) determined that wood lath shade permits an average of 18% light penetration compared to 28% for the black woven fabric. Proctor (1981) also found that light penetration was more uniform under black fabric shade than under wooden lath. Small differences were also recorded in the air and leaf temperatures beneath the two shade structures. Proctor (1980) measured the fresh and dry weight and chlorophyll content of leaves and concluded that the differences of temperatures and light penetration are probably not sufficiently great to evoke differential growth and plant yields. Preliminary

investigations by Proctor (1981) suggest that by measuring the leaf area index (LAI), the optimum plant density to achieve maximum root yield may be determined. Plants subjected to higher than optimal densities suffer increased stress due to competition among plants, subsequently predisposing them to infections or diseases.

Konsler (1980) established research plots at the Mountain Horticultural Crops Research Station at Fletcher, North Carolina to measure growth and developmental responses of ginseng to different mulches, plant densities, pH levels, and application rates of phosphorous and nitrogen. He found the largest roots were associated with oak and poplar sawdust and weathered pine needle mulches. Pine sawdust, which produced the largest seedling roots, also produced the smallest roots after two growing seasons. Seedling root weight was significantly increased and roots were more uniformly "carrot shaped" with soil of pH 5.5 rather than 4.4 or 6.5. Increasing soil phosphorus from 19 to 98 to 232 ppm tended to increase root weight. Spacing plants one inch apart in six inch rows during the second growing season reduced root weight increase compared to three inch spacings in six inch rows which stimulated root weight increase. He did not observe a clear-cut response to nitrogen fertilization.

Stoltz (1981) states that his research and that of Konsler (1980) are the only known studies on the nutrient requirements of ginseng. Stolz's work examined the effects of removing calcium, magnesium, potassium, and nitrogen on root weights. His findings conclude that calcium removal had the greatest impact on root weights, followed by potassium, and magnesium. The lack of a plant response to nitrogen deficiencies supports Konsler's (1980) findings.

III. RESEARCH METHODS:

AIR PHOTO COVERAGE

Beginning in 1938, the USDA - Agricultural Adjustment Administration, later the Agricultural Stabilization and Conservation Service (ASCS) have had aerial photographs taken of Marathon and other Wisconsin counties every 8 to 10 years. Successive flights were made in 1938, 1948, 1960, 1968, and 1978. In addition, the Marathon County ASCS office obtained aerial coverage with a 35 mm camera during the summer of 1980. It has been possible to identify and measure the area of ginseng gardens on these aerial photographs. The sequential coverage since 1938 makes it possible to note changes in distribution patterns and identify the expansion of cultivated ginseng in the county.

Traditionally ginseng culture in Marathon County has been centered in the towns of Hamburg and Marathon, and to a lesser extent in Rib Falls and Berlin (Fig. 3-A). According to George F. Hartman, County Agricultural Agent, UW-Cooperative Extension service, rapid expansion has occurred during the last 10 years and ginseng cultivation has spread primarily into the towns listed on Fig. 3-A.

The 1968 and 1978 photographs were taken at a scale of 1:15,840 (4"=1 mi.) and 1:20,000 (3.17"=1 mi.) respectively and were enlarged by the ASCS to 1:7,920 (8"=1 mi.). This larger scale made it easier to identify ginseng gardens and on the enlargements, they could usually be identified without the aid of instruments. Photographs of the county taken before 1968 were not available at the 1:7,920 scale. The quality of earlier air photos were poorer due to less sophisticated photographic equipment and years of handling. Interpretation of the

enlarged 1968 and 1978 photographs provided experience in the identification and measurement of ginseng plots, which aided in the interpretation of the earlier air photos.

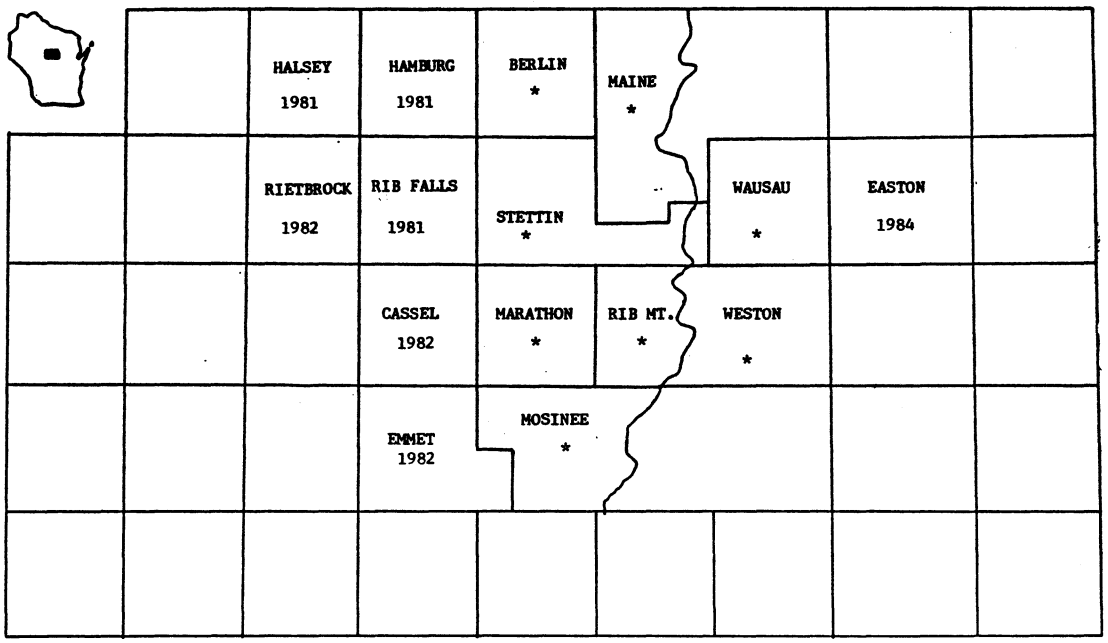


Figure 3-A: MARATHON COUNTY SOIL SURVEY STATUS

* Soil surveys completed.
The years represent the anticipated completion of the soil survey.

KEY ELEMENTS USED TO IDENTIFY GINSENG GARDENS ON AIR PHOTOS:

The shade canopies of wooden lath or black nylon mesh were the most distinctive features used to help identify ginseng gardens on the air photos. They could be easily differentiated from fields, buildings, and other features that have similar appearances. Key characteristics that make this distinction possible are:

1) Texture - wooden lath or nylon mesh canopy textures are usually distinct from others occurring on the photographs. The lattice network of wood shade structures resemble that of either a storm sewer grate, or a flower trellis that has been laid flat. All have in common a uniform grid pattern with rows of evenly spaced materials. Textures of the nylon mesh canopies were distinctive from surrounding features in that the cable and post supports beneath the fabric produced uniformly spaced "points" that are visible on the air photos. With experience, these structures can be recognized on texture alone without the aid of instruments. However, a four inch magnifying glass was used to insure greater accuracy in the identification. This was especially useful on the older photographs, which were obscured by numerous field boundaries delineated by the ASCS and also because these older photos were not available in the 1:7920 scale.

2) Tone - Wooden lath shade structures "weather" through years of use and take on color appearances that are easily distinguished from surrounding features. The color of weathered lath can be described as multiple variations of grey. These variations are the result of repairs in which

broken wooden lath is replaced annually with new lumber. Consequently, dark tones of grey color are materials that are more weathered, while lighter tones are those of newer materials. The combination of these tones assist in the identification of ginseng plots. Black fabric canopies are easily distinguished from other black features appearing on air photos as a result of the black mesh's deep uniform color.

3) Shadows - canopies are built approximately 6 to 7 feet over the ginseng gardens and cast shadows that are shorter and somewhat more clearly defined than those associated with buildings. Shadows from houses, barns, etc., were often obscured by trees and shrubs, paved or graveled parking areas and driveways, and by adjacent buildings that are varying heights. Small fields that might otherwise be mistaken for a ginseng plot could in most cases be eliminated based on the lack of shadows. Exceptions to this sometimes occurred when fence rows were present, but accurate identification could usually be made after examining the area with a magnifying glass or by using a stereoscope to produce a three-dimensional view of the area in question.

4) Shape/Size - many times buildings could have been confused with the smaller canopied areas. However, closer observations through magnification or use of a stereoscope revealed the roof peaks on buildings. In most cases ginseng fields cover a larger area than most buildings. Prior to interpreting the aerial photographs, it seemed possible that stone piles

occurring in fields might be identified as ginseng plots. This did not prove to be a problem because of the symmetrical nature of the canopies, compared to the irregular shape of most stone piles.

5) Location - ginseng requires well drained sites on which to grow. Where identification was difficult, the use of a stereoscope sometimes provided information on the local relief that helped to confirm an interpretation. For many questionable areas their relationship to other known cultural features sometimes provided useful clues in the interpretation.

6) Land Ownership - ginseng culture has been traditionally carried on by relatively few families over several generations. This resulted in a degree of consistency between property ownership and ginseng garden location when corresponding air photos and plat book locations were compared. Sometimes certain names were useful in correctly interpreting ginseng plots that were less distinctive from surrounding features.

7) Field Truth - the majority, if not all, ginseng grown in the county is harvested in the fall of the fourth year. Field checking for positive identification was possible only for the ginseng gardens that were recorded (interpreted) on the 1980 photographs.

Examples of both the wooden lath and black fabric canopies are indicated on the aerial photographs in Figure 3-B and 3-C to demonstrate in part the characteristics discussed above.

Figure 3-B: 1978 AERIAL PHOTOGRAPH - MARATHON COUNTY

Courtesy of Marathon County Agricultural Stabilization & Conservation Service (ASCS). NOTE: Scale has been reduced from the original photo.

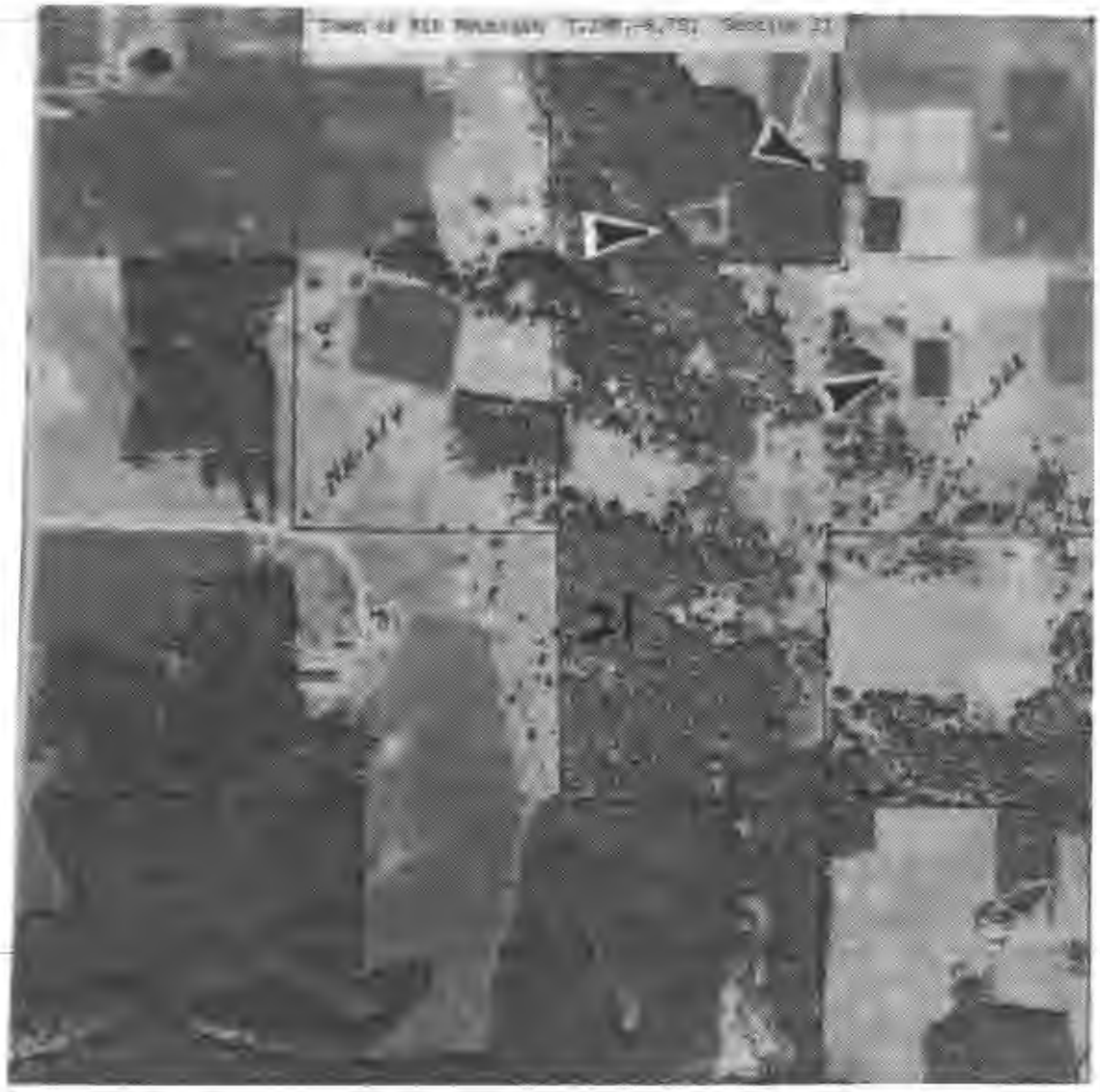


Figure 3-C: 1978 AERIAL PHOTOGRAPH - MARATHON COUNTY

Courtesy of Marathon County Agricultural Stabilization & Conservation Service (ASCS). NOTE: Scale has been reduced from the original photo.

AREA (ACREAGE) MEASUREMENTS

After identifying ginseng gardens on an air photograph, the size of each plot was determined by using the same template the ASCS used in their area measurements. A square inch on the template was divided into 100 equal square units. Each of these smaller increments represented different areas on the ground depending on the photograph's scale, e.g.:

	YEAR	SCALE	ACRES/SQUARE UNIT	ACRES/INCH^2
	1980	1:7,920	.1	10
ASCS	1978	1:7,920	.1	10
PHOTOS	1968	1:7,920	.1	10
	1960	1:20,000	.64	64
SCS	1948	1:20,000	.64	64
PHOTOS	1938	1:15,840	.4	40

Acreage was determined by counting the number of small units (on the template) that equaled the area identified as ginseng on the air photograph. The number of total units was then multiplied by the value represented by a single unit (Figure 3-D).

SOILS DATA

The Soil Conservation Service (SCS) is currently conducting the first comprehensive soil survey for Marathon County and eight of the fifteen towns comprising this study have already been mapped (Figure 3-A). The location of ginseng plots identified on the 1968, 1978, and 1980 air photographs were recorded in corresponding county plat books. The soils and property ownership were identified by comparing the plat maps with the 1968 air photographs used by the SCS when mapping the soils for each town (Figs. 3-E and 3-F).

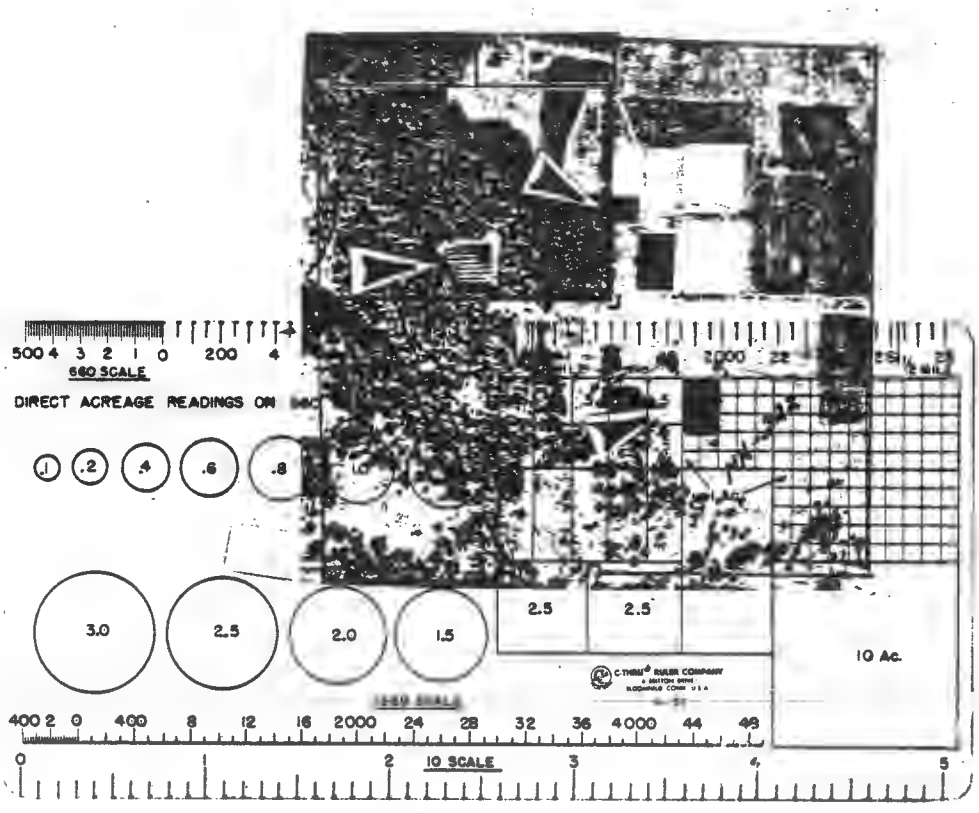


FIGURE 3-D: TECHNIQUE USED TO MEASURE GINSENG ACREAGE ON AIR PHOTOS (Actual ASCS Template Shown)

1978 Aerial Photograph - Town of Rib Mountain
NE 1/4 T28N-R7E Section 21 - Marathon County

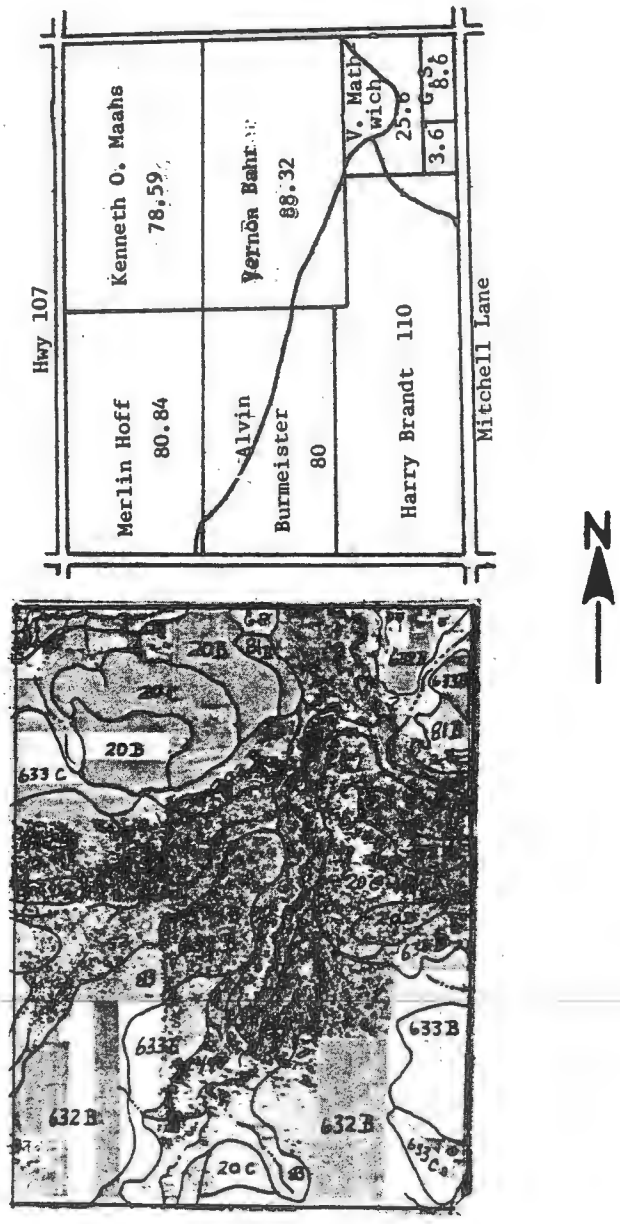


FIGURE 3-E: PLAT MAPS AND CORRESPONDING SOIL SURVEY MAPS

Town of Berlin T.30N.-R.6.E. Section 31
NOTE: Scale has been reduced from original photo

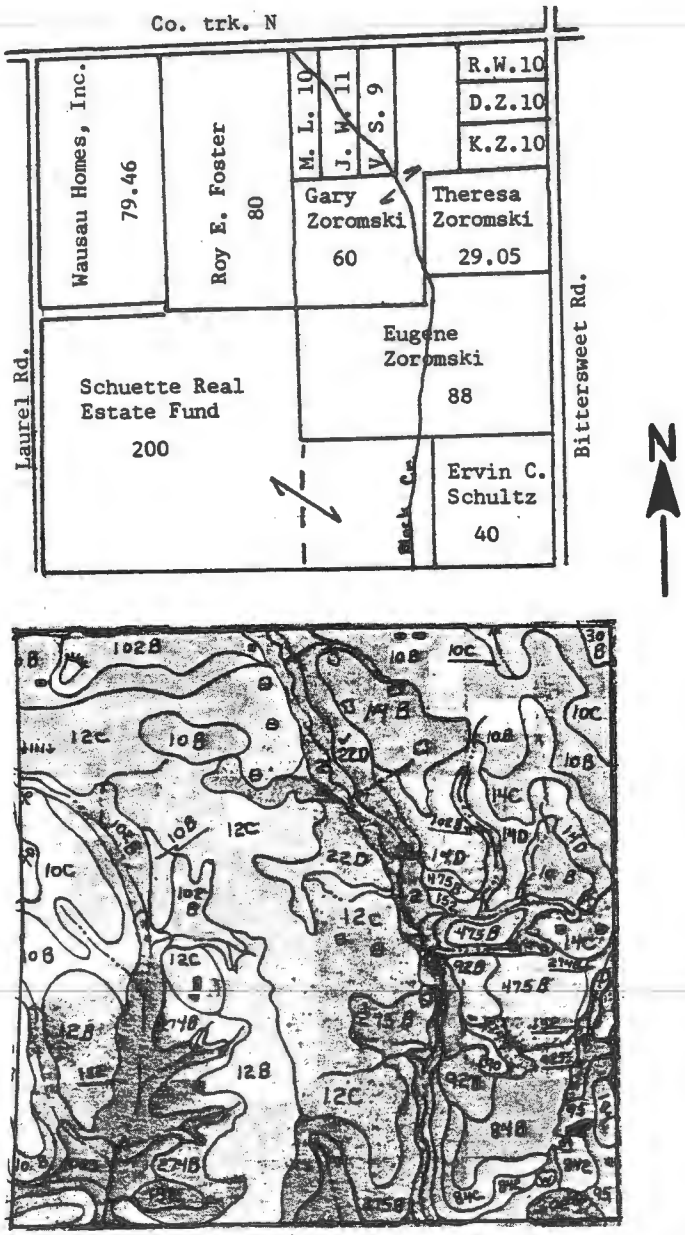


FIGURE 3-F: PLAT MAPS AND CORRESPONDING SOIL SURVEY MAPS

Town of Rib Mountain T.28N.-R.7E. Section 21
NOTE: Scale has been reduced from original photo

IV. RESULTS AND DISCUSSION:

MARATHON COUNTY'S GINSENG CULTURE PRIOR TO 1938

It was stated earlier that the cultivation of ginseng in Marathon County began soon after the start of this century. However, reports in the literature of that time are inconclusive and do not document this early growth. Books published on the county's history by Marchetti (1913), Kluether and Lorence (1977) have recognized the uniqueness of cultivating ginseng, but do not account for the early expansion. Articles and feature stories by local newspapers since ginseng cultivation began in 1904 have also contributed little regarding the development of ginseng culture prior to 1938. The lack of specific information comes as no surprise when the difficulty in data collection for parts of this study are considered. This study would not have been possible without aerial photographs, especially if the author had to rely on available literature and personal interviews with local growers. Ginseng culture began in Marathon County with families closely guarding their secrets and little has changed since that time.

Pinkerton (1947), Kluether and Lorence (1977) report that it required several years for the Fromm family (among the earliest growers in the county and now a leading producer) to overcome the problems of cultivating ginseng. Pinkerton (1947) states that Fromms began cultivation in 1905; in 1909, 1923, and 1933 they planted .5, 5, and 18 acres respectively. While this information concerns a single operation, it can be observed that several years were required before larger plantings were possible. Factors which explain this slow rate of expansion are 1) initial seed stock and seedlings had to be collected from wild forest populations and 2) several years of

successful plant domestication were necessary before greater supplies of both seeds and seedlings were available for larger plantings. Also, disease and pest control methods were not clearly defined and significant losses were common at this time.

Figure 4-A indicates that by 1938, 253 acres of ginseng were under cultivation within the designated study area. The Fromm family has large land holdings in the Town of Hamburg and in 1938 they were cultivating approximately 75 acres of ginseng. On the basis of this and the information previously presented in the section on Wisconsin History, this author concludes that prior to 1938, ginseng was cultivated by relatively few individuals growers. Furthermore, Pinkerton (1947) notes that in the 1930's, many growers were forced out of business because of the Great Depression and political upheaval in China. It is assumed that only the larger, more successful growers like the Fromms, were able to survive these hard economic times.

MARATHON COUNTY'S GINSENG CULTURE 1938-1980

Interpretation of aerial photographs revealed that in 1938, 253 acres were being used for ginseng cultivation in Marathon County. The breakdown in acreage by towns is shown in Figure 4-A. The combined acreage for 1938 was on land owned by 76 different individuals. However, it cannot be assumed that these individuals were all cultivating ginseng. As early as 1938 it is possible some land was leased or rented by individuals involved in the commercial production of ginseng. This land would be registered in the plat book under the name of the owner.

By examining both Table 4-A and Figures 4-A through 4-F it becomes apparent that acreage of commercial ginseng production in the various towns has changed over the years. In 1938 the Town of Hamburg was the leading producer, but since then the acreage has declined and today Hamburg is only a minor contributor. By comparison the acreage of ginseng cultivation in the Towns of Berlin, Stettin, Marathon, and Mosinee has increased through the years and are now the largest producers.

The shift in production is due mainly to the fact that traditionally it has not been possible to plant and grow more than one crop of ginseng on a given piece of land. Second crops appear to do well during the plant's early life cycle, but have died during either the first or second season. Most growers believe that this is caused by an accumulation of disease organisms in the soil that are parasitic to new roots and plants. Others think that the problem is due to a micro-nutrient deficiency in the soil (Harris, 1978). This problem has

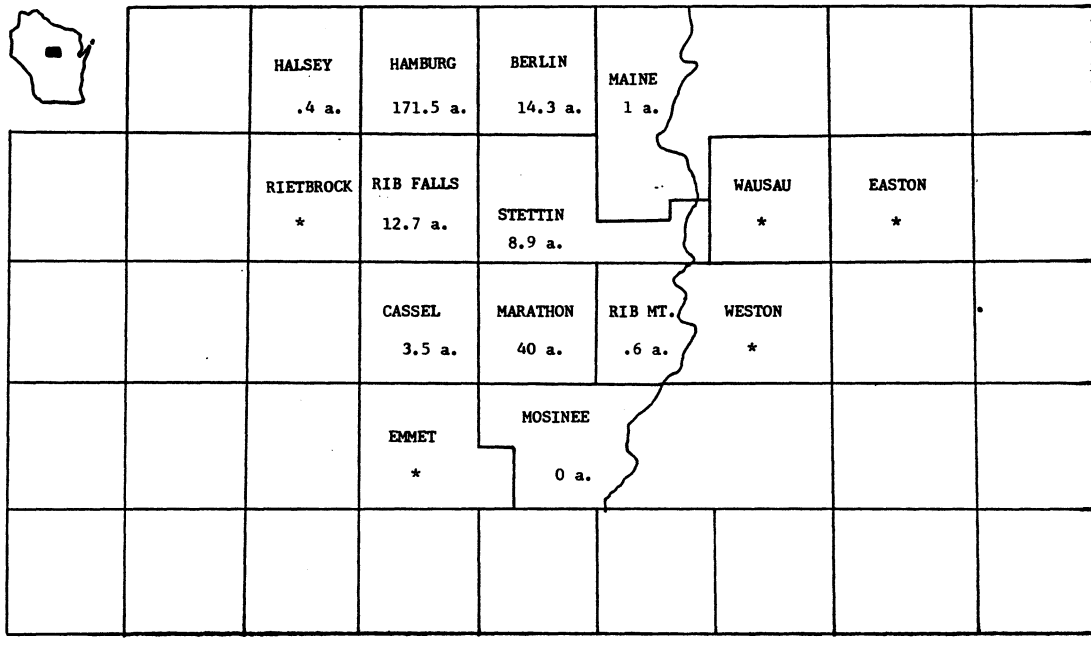


FIGURE 4-A: 1938 GINSENG ACREAGE TOTAL ACREAGE 252.9

* Aerial photographs for these townships were not considered in that little, if any, ginseng appears in the years 1968 & 1960.

been mainly confined to the northern United States (Wisconsin), Ontario, and parts of Asia. Commercial growers in the southern United States are able to produce two or more successive crops of ginseng before a failure or major reduction in production occurred. After allowing the land to then lie fallow for a few years, they could often expect satisfactory yields for one or two additional crops (Lewis, 1980). However, Jenkins (1980) reports that some southern growers have been experiencing the same problems as their northern counterparts when attempting to plant second crops.

Many of the larger, established growers in Marathon County feel that this problem may soon be eliminated. Over the last few years several growers have been experimenting with the use of methyl bromide, a gaseous fumigant, to kill disease organisms that accumulate in the soil. The chemical is injected into the soils that have been previously used for ginseng production. Results have not been conclusive, but they are promising. Some growers report that plants growing for 2-3 years on these fumigated soils look as good as those growing on soils that had never been used to grow ginseng. The use of fumigants to sterilize soil is not new. Two of the more traditional methods are: 1) sterilization using steam, and 2) sterilization using formaldehyde. Both these treatments have been commonly used with some degree of success in the southern United States. However, neither of the treatments have been successful in Marathon county. As a result, until methyl bromide or some other fumigant proves to be successful without undesireable environmental effects from prolonged use, growers will have to develop new fields for each new garden and large cultivators will probably have to either purchase or lease additional land.

	1938	1948	1960	1968	1978	1980
1. Halsey	.4	-	-	-	.8	3.7
2. Hamburg	171.5	36.4	77.9	.4	9.9	19.2
3. Berlin	14.3	4.3	-	130.8	143.2	163.3
4. Maine	1	1.3	-	4.2	12.8	28.1
5. Rietbrock	-	-	-	-	3.5	7.4
6. Rib Falls	12.7	8.7	7.7	18.5	72.9	109.5
7. Stettin	8.9	3.3	26	33.6	156.8	194.3
8. Wausau	-	-	-	5.6	5.1	8.8
9. Easton	-	-	-	-	-	.4
10. Cassel	3.5	-	2.9	5.9	52	95.3
11. Marathon	40	23.9	28.3	64.9	191.9	265.4
12. Rib Mt.	.6	-	1.1	3.3	16.9	24.5
13. Weston	-	-	-	.8	1.5	1.3
14. Emmet	-	-	-	-	16.3	38.2
15. Mosinee	-	-	10	10.6	72.7	117.3
TOTAL	252.9	77.9	153.9	278.6	756.3	1081.1

TABLE 4-A: ACREAGE SUMMARY BY TOWN, 1938-1980

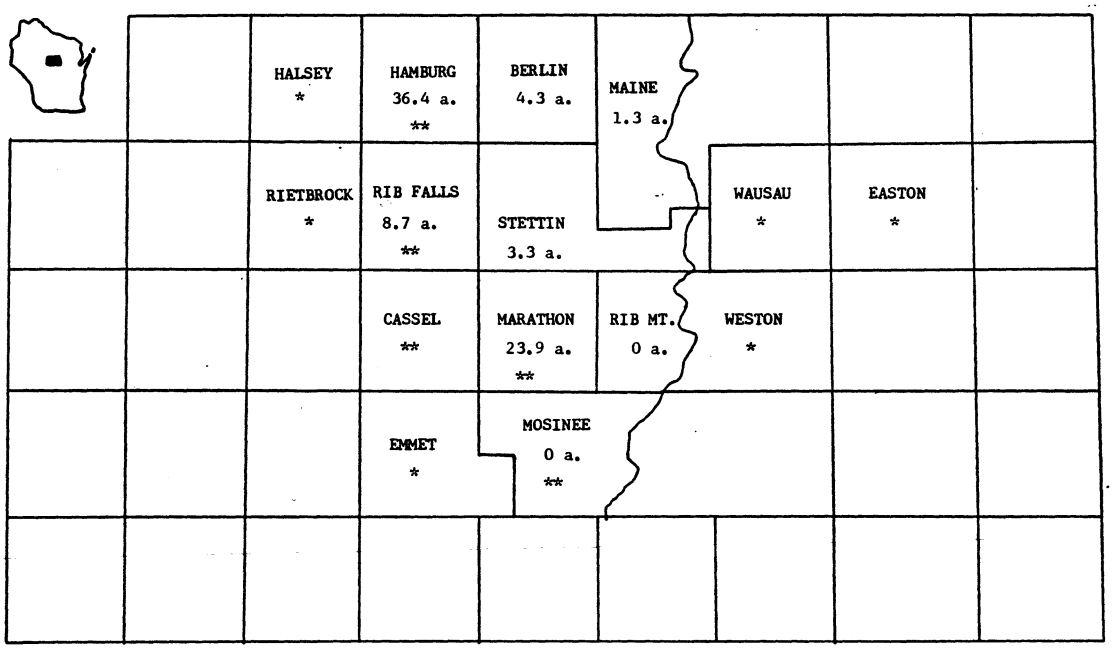


FIGURE 4-B: 1948 GINSENG ACREAGE-TOTAL ACREAGE 77.9

* Aerial photographs for these towns were not considered in that little, if any, ginseng appears in the years 1968 & 1960.

**Data for these towns is incomplete due to missing aerial photographs.

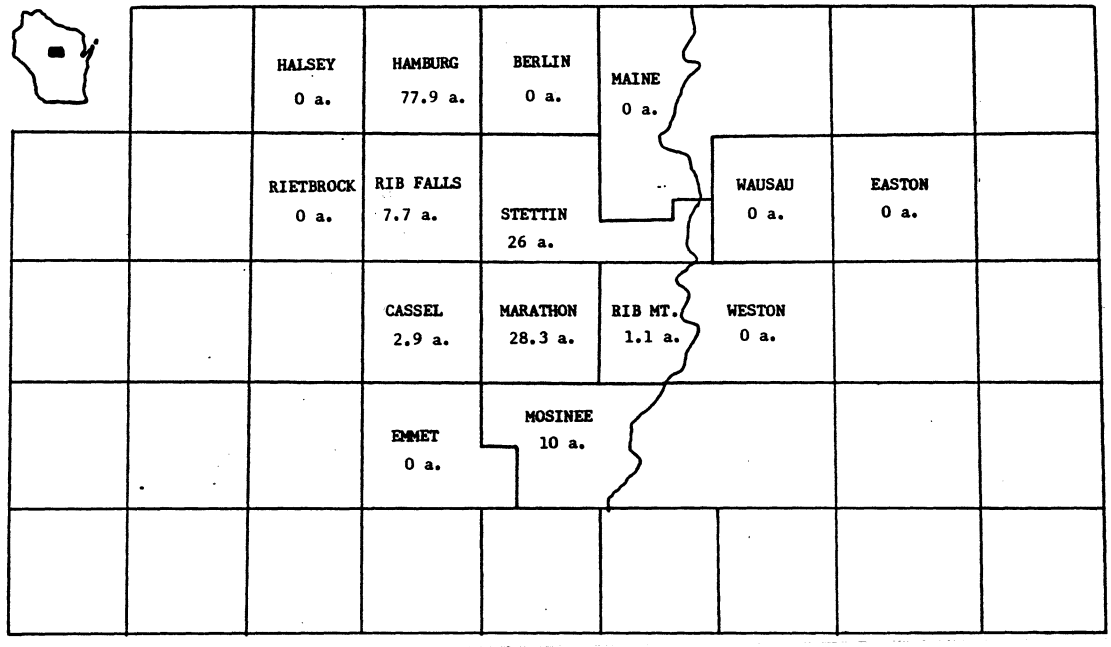


FIGURE 4-C: 1960 GINSENG ACREAGE-TOTAL ACREAGE 153.9

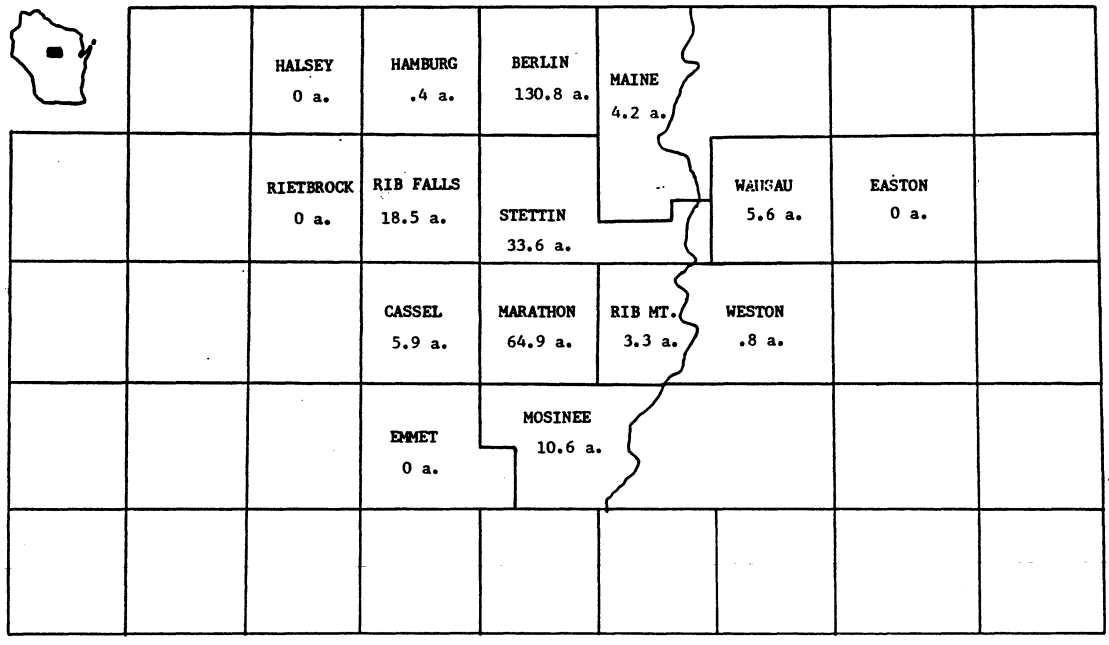


FIGURE 4-D: 1968 GINSENG ACREAGE-TOTAL ACREAGE 278.6

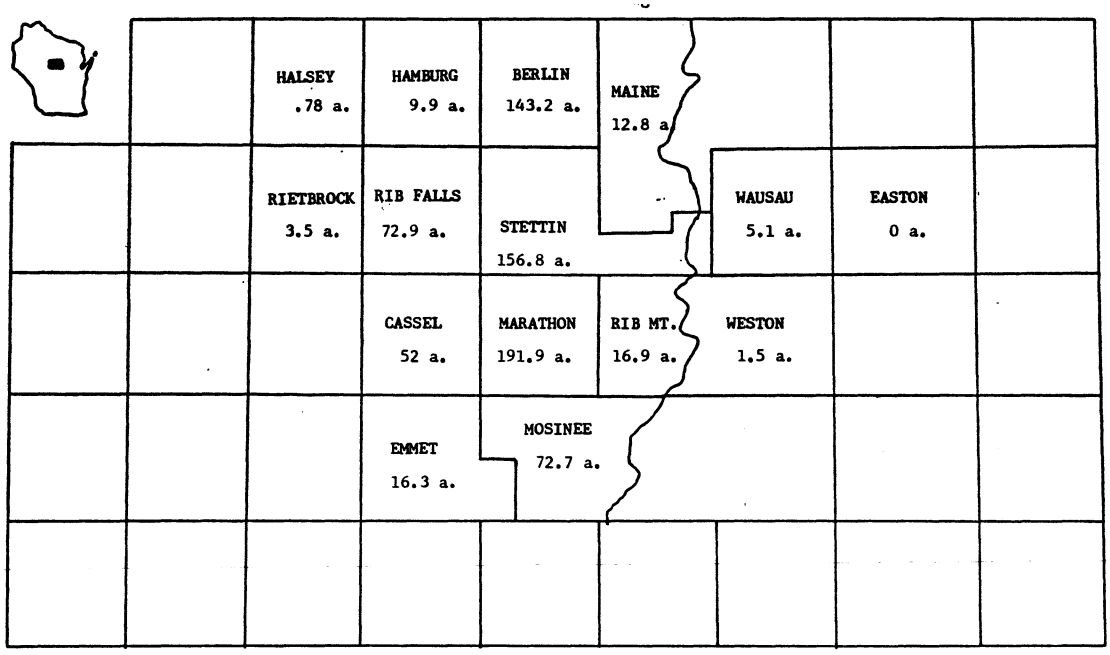


FIGURE 4-E: 1978 GINSENG ACREAGE—TOTAL ACREAGE 756.3

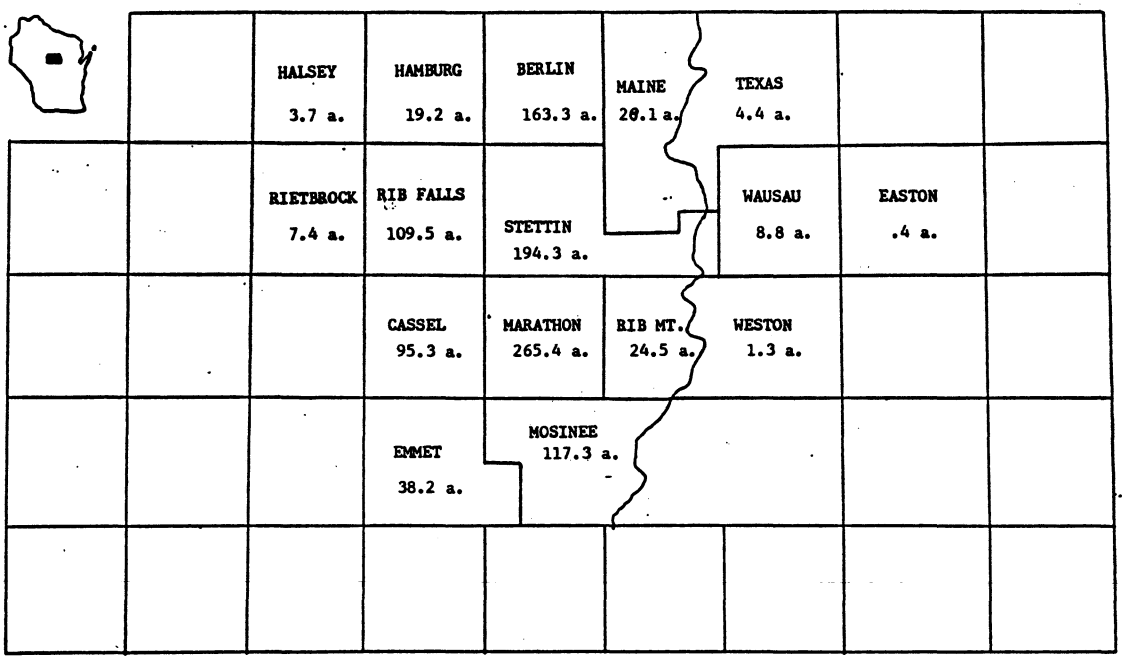


FIGURE 4-F: 1980 GINSENG ACREAGE TOTAL-ACREAGE 1081

ASSESSMENT OF PERSONS ENGAGED IN GINSENG CULTIVATION

Although it was not possible to distinguish between individuals who leased land from those who cultivate ginseng on their own property, it is reasonable to assume that the number of property owners closely parallels the number of persons engaged in ginseng farming. This assumption is based on interviews with several growers who have indicated that leasing is not that common and that larger growers are more likely to lease land than persons with smaller operations.

A breakdown on the number of landowners in 1938 and the size of ginseng fields on their property is presented in Table 4-B.

TABLE 4-B: 1938 - LAND OWNERS AND GARDEN SIZE

SIZE (ACRES)	# OF PROPERTY OWNERS	COMBINED ACREAGES	% OF TOTAL (252.9 ACRES)
Greater than 5	6 (8%)	160.5	63%
3-5	10 (13%)	39.8	16%
1-3	19 (25%)	32.3	13%
Less than 1	41 (54%)	20.3	8%
	76 (100%)	252.9	100%

Table 4-B indicates that 54% of the landowners accounted for only 8% of the county's total ginseng acreage for 1938. This trend has continued through the 1980 data.

A decline in ginseng production is recorded on the photos taken in 1948. The two major factors responsible for this decline were: 1) the loss of an export market which resulted from trade interruptions due to the Sino-Japanese War, and by World War II and 2) the increased occurrence of root rot in the 1940's, which caused the destruction of many acres of ginseng and consequently forcing many growers out of the business (Kluether and Lorence, 1977). Figure 4-B illustrates the

acreage for each town in 1948. A comparison with Figure 4-A shows that without exception a decline occurred for every town during the 10 year interval. The most dramatic decline took place in the town of Hamburg. Table 4-C below provides information on property owners and the size of the gardens appearing on their properties for 1948.

TABLE 4-C: 1948 - (INCOMPLETE) LAND OWNERS AND GARDEN SIZE

SIZE (ACRES)	# OF PROPERTY OWNERS	COMBINED ACREAGES	% OF TOTAL (77.9 ACRES)
Greater than 5	1 (3%)	29.9	38%
3-5	3 (10%)	10.8	14%
1-3	16 (52%)	31.4	40%
Less than 1	11 (35%)	5.8	7%
	31 (100%)	77.9	99%

The acreage measured in 1960 almost doubled the acreage measured in 1948. The increase reflects a recovering export market that began after 1950 when the United States resumed communication and trade relations with the Orient, particularily Hong Kong. Table 4-D below presents the relation between garden sizes and land owners for that year.

TABLE 4-D: 1960 - LAND OWNERS AND GARDEN SIZE

SIZE (ACRES)	# OF PROPERTY OWNERS	COMBINED ACREAGES	% OF TOTAL (153.9 ACRES)
Greater than 5	6 (15%)	114.7	75%
3-5			
1-3	19 (46%)	30.3	20%
Less than 1	16 (39%)	8.9	6%
	41 (100%)	153.9	101%

A parallel exists between 1960 (Table 4-D) and 1938 (Table 4-B) in that the majority of landowners had less than three acres of ginseng and in combination, contributed less than 25 percent to the county's

total acreage. Figure 4-C indicates that although the towns of Hamburg and Marathon were the primary producers in 1960, the culture was spreading into the towns of Stettin and Mosinee.

Between 1960 and 1968, the county's ginseng acreage increased by more than 55 percent. The increase was stimulated by the steadily rising demand and higher prices paid for ginseng. The average price per pound of cultivated root jumped from $19.62 in 1964, to $32.61 in 1968. During this same time production dropped and the amount exported in 1968 was less than in 1964 (Table 2-D). This generated greater demand and higher prices, and in 1967 and 1968 individual growers responded by bringing more acreage into ginseng cultivation. However, since four years are required to produce a marketable root, this increase in acreage did not affect the amount exported until 1972, when the total American ginseng exports were 227,549 pounds compared to 133,701 pounds in 1968. Although figures representing Marathon County's contribution to this total are not available, it should be substantial since the county is credited with 85-90 percent of the United States domestic production.

A review of the maps for 1960 and 1968 (Figures 4-C and 4-D) indicate a significant shift in ginseng production between the towns of Hamburg and Berlin. This change was caused by a shift in the activities of the Fromm brothers, traditionally the town of Hamburg's largest cultivators of ginseng. During the sixties, the Fromm brothers purchased 320 acres in the town of Berlin. The study of the 1968 aerial photographs revealed the Fromms no longer had ginseng gardens in

Hamburg, but instead had shifted cultivation entirely to the town of Berlin. By 1968 more than 100 acres in section 20 were planted to ginseng.

The number of property owners with ginseng gardens on their land increased with the growth in the acreage used for ginseng production. Table 4-E suggests that the relationship between the number of landowners and the size of gardens remained consistent with that of 1948.

TABLE 4-E: 1968 - LAND OWNERS AND GARDEN SIZE

SIZE (ACRES)	# OF PROPERTY OWNERS	COMBINED ACREAGES	% OF TOTAL (278.6 ACRES)
Greater than 5	7 (10%)	171.2	61%
3-5	8 (11%)	29.1	10%
1-3	35 (48%)	68.5	25%
Less than 1	23 (32%)	10	4%
	73 (101%)	278.8	100%

From 1968 to 1978, Marathon County experienced a sharp increase in the number of growers and the total acreage increased to more than 750. Rapid growth continued during this 10 year period in response to an expanding export market and the subsequent rise in the root's value from $33 to $45 (Tables 2-C and 2-D). A map for 1978, Figure 4-E, shows the rate at which expansion has occurred. The towns of Rib Falls, Stettin, Marathon, and Mosinee have experienced most of the county's growth. The towns of Hamburg continues to be a minor contributor, while expansion of the ginseng culture has become significant in the towns of Cassel, Rib Mountain, and Emmet. The data tabled below indicates the relation between property owners and garden size for 1978.

TABLE 4-F: 1978 - LAND OWNERS AND GARDEN SIZE

SIZE (ACRES)	# OF PROPERTY OWNERS	COMBINED ACREAGES	% OF TOTAL (757.3 ACRES)
Greater than 5	42 (16%)	437.4	58%
3-5	34 (14%)	136.5	18%
1-3	81 (34%)	142.9	19%
Less than 1	90 (36%)	40.5	5%
	247 (100%)	757.3	100%

The continuous increase in acreage that began after 1968, has continued through 1980 (Table 4-G) with the sharpest increase occurring during the last two years. Interpretations from the 1980 ASCS aerial photographs disclosed that nearly 1,100 acres were being cultivated. This represents a 70 percent increase in the acreage used for ginseng production since 1978. Expansion of the county's ginseng culture in the past two years has been encouraged by the substantial price increase (Table 2-C). The price in 1978 was depressed as a result of a change in U.S. relations with Taiwan and instituting trade relations with mainland China, (Hanousek, 1979).

TABLE 4-G: 1980 - LAND OWNERS AND GARDEN SIZE

SIZE (ACRES)	# OF PROPERTY OWNERS	COMBINED ACREAGES	% OF TOTAL (1,078 ACRES)
Greater than 5	63 (7.7%)	589.7	54.7%
3-5	48 (13.5%)	196.7	18.2%
1-3	124 (34.9%)	223.0	20.7%
Less than 1	120 (33.8%)	68.4	6.3%
	355 (99.9%)	1077.8	99.9%

SITE SELECTION/SOILS IDENTIFICATION

Wild ginseng prefers forested hillsides and is rarely found on lower, poorly drained soils. The plant thrives best on well drained soils that have been formed by incorporation of leaf mold and decayed wood from hardwood forests into the surface horizon. These humus rich soils have excellent structure and been made porous and kept loose by the growing and decay of roots from trees and other forest plants and by mixing and burrowing of earthworms. This has facilitated a favorable air-water relationship which is required for ginseng growth.

When the cultivation of ginseng first began in Marathon County, the preferred sites were virgin forest soils that had just been cleared for farming. Since this is no longer a viable option, preferred sites in recent years have been gently sloping sod covered fields that have remained fallow for several years. The accumulation of grass and root residues over the fallow period increases the organic matter content of the surface layer in the same way as the annual addition of leaves in hardwood forests. This has provided certain soils with a desireable soil structure (air-water relationship) for growing ginseng successfully.

Most of the soils on which ginseng was planted in 1968, 1978, and 1980 can be briefly characterized as soils having textures which range from silt loam to sandy loam. Slopes for the soils range from 2-15%, with the majority falling into the 2-6% slope category. Several other characteristics are described in the line diagrams below:

AVAILABLE WATER HOLDING CAPACITY

Low	Moderate	High
Moberg Series (gravelly loam) Chetek Series (sandy loam)	Fenwood and Marathon Series (silt loam)	Rozellville Series (silt loam)

ORGANIC MATTER CONTENT - SURFACE LAYER

Low to moderately low	Moderately low to moderate	Moderate to high
Moberg Series (gravelly loam)	Rozellvile Series (silt loam) Marathon Series (silt loam) Chetek Series (sandy loam)	Fenwood Series (silt loam)

SURFACE RUNOFF FROM CULTIVATED AREA

Slow	Moderate	High
Moberg (gravelly loam) 12B Chetek (sandy loam) 84B	Moberg (gravelly loam) 12C Fenwood Series (silt loam) Rozellville Series (silt loam) Marathon Series (silt loam)	

WATER - AIR MOVEMENT - UPPER PART OF SUBSOILS

Moderate to Moderately Rapid	Moderately Rapid	Rapid
Moberg (gravelly loam) 12B	Moberg (gravelly loam) 12C Fenwood Series (silt loam) Rozellville Series (silt loam) Marathon Series (silt loam) Chetek Series (sandy loam)	

WATER - AIR MOVEMENT - LOWER SUBSOIL AND IN THE SUBSTRATUM

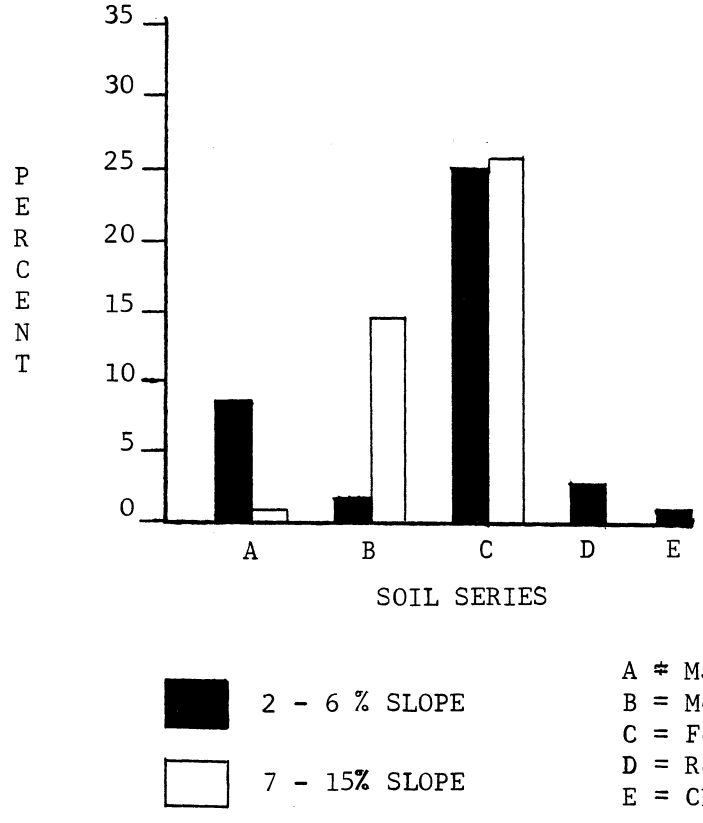
Low	Moderate	Rapid
	Fenwood Series (silt loam) Rozellville Series (silt loam)	Moberg Series gravelly loam) Marathon Series (silt loam)

The study of ginseng cultivation in Marathon County has involved fifteen towns. Soil surveys have been completed for eight of these towns while the Towns of Rib Falls, Emmet, and Hamburg have been partially mapped. Figure 3-A shows the current status of the county's soil survey.

The soils on which new ginseng gardens were established in 1968, 1978, and 1980 have been identified in the towns with completed soil surveys. Figures 4-G through 4-I list the five main soils and provides a summary of the percentage each soil represents of the total ginseng acreage. When examining these Figures, it is interesting to note that growers traditionally select garden sites by topographical location and experience and most do not consider soil type. In literature on site selection, Root (1905), Harding (1972), Lewis (1980), and others describe the most favorable location for ginseng is on 2 to 6% slopes that allows excess surface waters to drain away and with a north or east exposure to avoid excess solar radiation. Soils that are humus rich, having a surface texture layer of sandy clay loam, loamy sand, or silt loam and underlain by porous subsoils are preferred.

SUMMARY OF 1968 SOILS:

In 1968, two hundred fifty-four acres of ginseng were grown in the eight townships that had completed soil surveys. One hundred ninety-four acres, or 77% of the total acres cultivated were on the five soil series shown below in Figure 4-G.



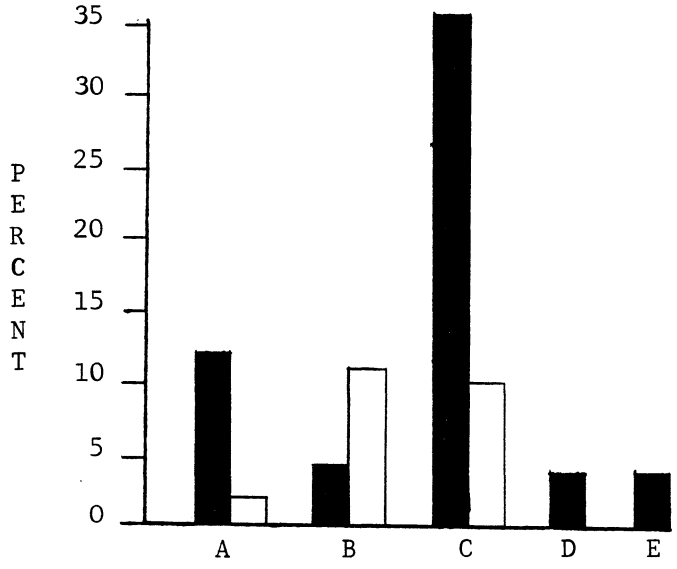
TOTAL ACREAGE-278 SCS SURVEYED-254

PERCENT TOTAL-76.5%

FIGURE 4-G: 1968 PREFERRED GINSENG SOILS

SUMMARY OF 1978 SOILS

Of the 756.3 acres of ginseng grown in the fifteen townships in 1978, 603.1 acres were within the eight townships that had completed soil surveys. Figure 4-H below provides a summary for 1978 and indicates that 80.9% of the ginseng was grown on the five soil series.



2 - 6 % SLOPE

7 - 15% SLOPE

A = Marathon sil
B = Moberg gl
C = Fenwood sil
D = Rozellville sil
E = Chetek sl

TOTAL ACREAGE-756 SCS SURVEYED-603

PERCENT TOTAL- 80.9%

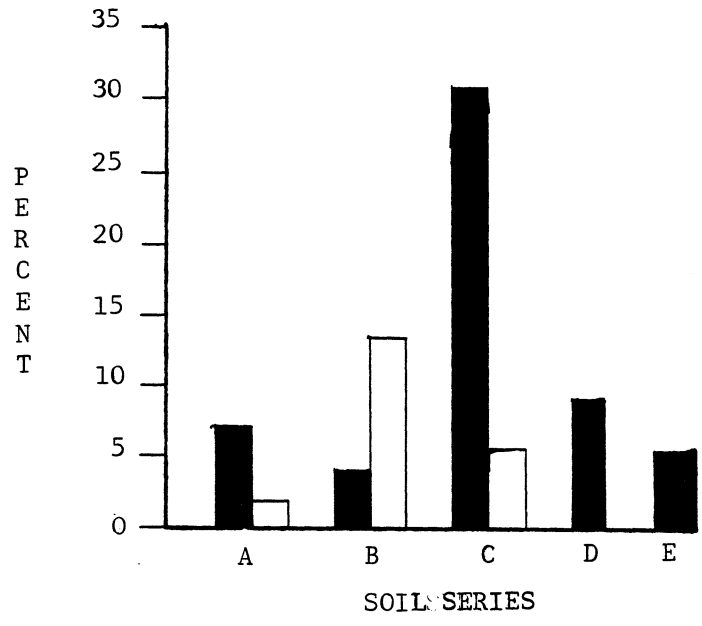
FIGURE 4-H: 1978 PREFERRED GINSENG SOILS

SUMMARY OF 1980 SOILS:

Interpretation of the 1980 aerial photographs revealed that 1100 acres were being cultivated for ginseng production in 16 towns. The town of Texas was included in the 1980 survey to determine in part if the culture had continued to expand into new areas. Interpretations of the 1978 photographs for the town of Texas did not record any ginseng gardens. Two years later, 4.5 acres were being cultivated there. In recent years Lincoln County has experienced an influx of new ginseng gardens. The extent of growth in Lincoln County is not known at present and will not be included in this inventory.

Figure 4-I indicates that for 1980, 800 acres were being used for ginseng production in the towns with a completed soil survey. Of these 800 acres, 635 acres or 79% occurred on the five dominant soils shown below.

These data illustrate, that since 1968, Marathon, Moberg, Fenwood, Rozellville and, to a lesser extent, Chetek, have been the dominant soil series used for the cultivation of ginseng. The line diagrams on pages 74 and 75 gave some important characteristics of these soils which have supported the long held premise that among other requirements, ginseng needs a well-drained soil for optimum growth and maturation. A more detailed description of these soil series is found in Appendix C.



TOTAL ACREAGE 1080 SCS SURVEYED 804

PERCENT TOTAL 79%

FIGURE 4-I: 1980 PREFERRED GINSENG SOILS

V. GINSENG CULTIVATION TECHNIQUES IN MARATHON COUNTY

"--Commercial ginseng cultivation is still considered an art rather than a science in Marathon County. Successful techniques and practices are the result of years of experience and quietly passed along family lines for generations."

--(Hartman, pers. comm.- 1980)

The following discussion is based on 1) a survey of historical and current literature, 2) interviews with thirteen Marathon County growers, 3) several interviews with George Hartman, Marathon County Agricultural Agent, and Paul Hsu, of Hsu's Ginseng and Enterprises Company, 4) discussions with researchers from the University of Wisconsin-Madison and 5) discussions with researchers at the Mountain Horticultural Crop Research Station at Fletcher, North Carolina. In addition, valuable information was gained through this author's attendance at the 2nd National Ginseng Conference held in Jefferson City, Missouri (1980), and the 3rd North American Ginseng Conference held in Asheville, North Carolina (1981).

In many respects, the cultivation of ginseng has not changed to the degree one might expect since it was first undertaken in this country in the 1880's. Early written guides, referred to in the Literature Review Section, have discussed techniques of cultivation and common disease problems (Stanton, 1892; Nash, 1895; Kains, 1912; Van Fleet, 1913; Stockberger, 1921). Since these accounts of early research were published, little additional information has become available to provide ginseng growers with information about changes that have taken place. Books of a general nature have been published in recent years by Veninga (1973), Dixon (1976), Heffern (1976), Harris (1978), Hou (1978) and others, but they contain information of limited

value to individuals seriously involved with ginseng culture. A short USDA publication entitled "Growing Ginseng" was published in 1973, and revised by Williams and Duke (1978). Unfortunately, the authors failed to discuss either fungal diseases or the use of pesticides, which are two important issues for anyone growing ginseng at the plant density suggested in the article. These authors also advocate obtaining initial stock from woodlands, without mentioning the legal restrictions of collecting plants from private or public land. On the whole the article adds little to the early works, despite its recent publication date. Two pamphlets that contain more specific information on planting, disease and pest control, and fertilization were published recently, (Collins, 1973 and Lewis, 1980). While both are well written, their treatment of disease control is generalized and concerns only Alternaria Blight. Caution is advised when following their recommendations since many diseases common to ginseng have symptoms similar to those of Alternaria Blight, but require different methods for control. The following discussion is not intended to fill the gaps left by the efforts of others, but rather to describe practices that are common, but not necessarily unique, to growers of Marathon County.

Early literature and current management practices in Marathon County agree on several issues. Descriptions of the symptoms and causes of ginseng diseases have changed little through the years. Similarly, methods of seed preparation, planting techniques, preferred soil textures, aeration and shade requirements, and root drying procedures remain much as they were decades ago. The areas of greatest change in the practices of Marathon County growers include: 1) disease

and pest control methods, and the use of chemicals in disease and pest control, 2) eliminating the practice of raising seedlings in nursery beds and later transplanting to permanent beds, 3) partial replacement of wooden lath sunshades with a fabric cover of black woven polypropylene, 4) the introduction of oat straw mulch, and 5) increased mechanization of most all operations. The use of fertilizers is an area of controversy, and two schools of thought on the issue exist today even as they did among early growers. Critics believe that the use of fertilizers will lower the resemblance of cultivated root to wild root, which reduces the value of the cultivated product, and that accelerated growth through fertilization will make plants more susceptible to disease. Others believe that these criticisms are unjustified, and that fertilization is worthwhile because it stimulates increased growth. More changes in the culture of ginseng can inevitably be expected in the future, given the economic incentive for improving methods, and the current emphasis on research by Konsler, (1980), Stoltz, et al, (1980), Stoltz, (1980), Proctor (1980 and 1981) and others.

In 1980, it was estimated that 300-350 families (Table 4-G) were involved in cultivating ginseng in Marathon County. In most cases production is on a small scale, but even these small operations require work 12 months of the year. After the roots are marketed in the fall, the buildings used to dry and store the roots are converted to other purposes. Between December and April these buildings are frequently used to prepare or assemble new equipment for the coming season. Where a wood lath sunshade is used, repair of the old and preparation of the

new sections of the shade presents a sizeable task in itself. Each section measures 4'x12' and is made up of three 1"x3"x12' (Figure 5-A) runners with approximately 60 pieces of wooden lath nailed across. The laths are spaced about one inch apart to permit 20 to 25% penetration of the available sunlight. Hemlock and cedar are most commonly used in the construction of these units. One person can usually nail together 1,000 sections (enough to cover one acre) per month.

Spray Program:

Wooden lath sections or a black woven polypropylene fabric shade is usually erected over the gardens by the second week in May after the threat of a late snowfall have passed. Prior to installing the shade structures, most experienced growers will spray the mulch with either Captan or a formaldehyde solution (1 gallon formaldehyde to 200 gallons of water) before the new seedlings emerge. This is a preventive measure taken because mulches may harbor the dormant mycellium that is responsible for causing Alternaria Blight. This organism becomes active at about the same time seedlings begin to push their way through the mulch. Also at this time many growers will spread Mesurol bait and zinc phosphide treated grain to kill slugs and mice respectively.

By late May-early June the artifical shade (Figure 5-B) is in place and the emergence of the ginseng plants has begun. At this time most growers begin a walking inspection of their gardens either daily or on alternate days to check for the appearance of disease, pests, or other problems. Once the plants have emerged, some growers continue to use Captan, which is the same chemical as Dithane M-22, but in a more concentrated form. This practice is especially common if first year

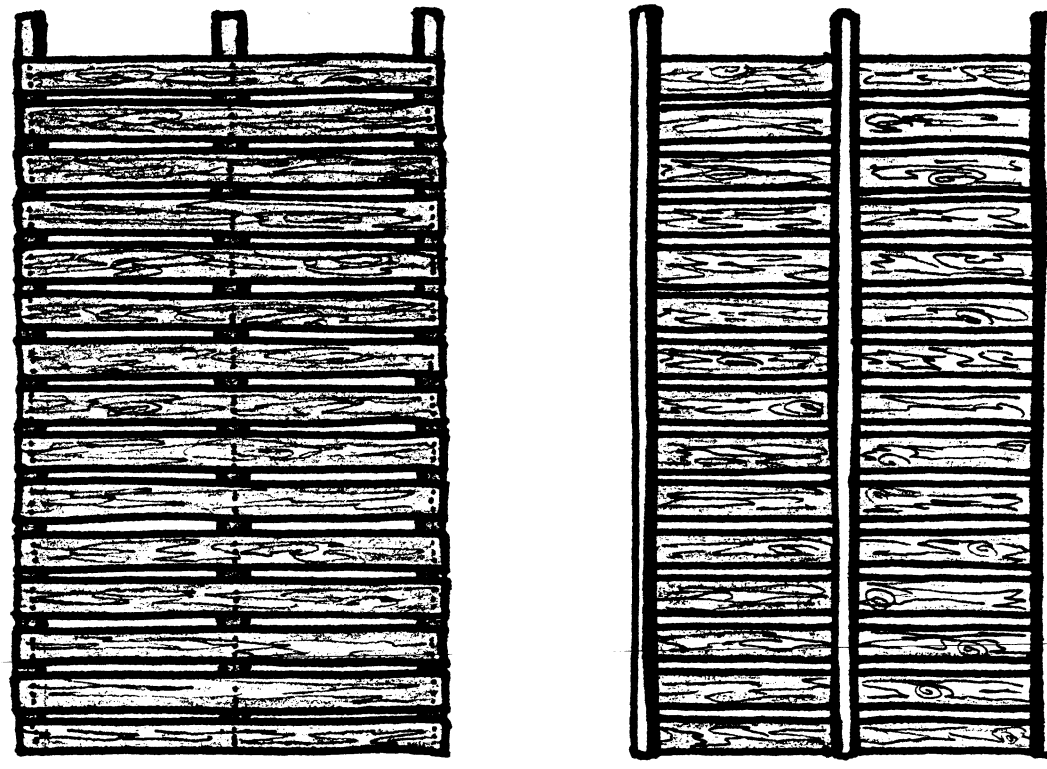


FIGURE 5-A: WOOD SECTIONS OF LATH SHADE.
LEFT - SKYWARD VIEW. RIGHT - UNDERSIDE VIEW.

FIGURE 5-B: TOP - POLYPROPYLENE FABRIC SHADE
BOTTOM - WOODEN LATH SHADE

plants have begun dying from damping off. This disease is caused by a fungus called Rhizoctonia, and results in a decay of the stem at the surface of the soil. Captan is usually successful in killing this fungus, whereas M-22 is not strong enough. After the leaves of the plants open completely, growers will begin spraying with Dithane M-22 or M-24 for the prevention and control of Alternaria Blight.

Large and more experienced growers adhere to a "rigorous" spray program. Three and four year old plants may be sprayed at 7-9 day intervals. After a major rainstorm, gardens are sprayed as soon as equipment can be brought into the fields and the 7-9 day spray rotations begin at this time. Hot, humid conditions are ideal for the development of the fungus that causes Alternaria Blight. Spray programs are designed to prevent blight rather than to stop it once it has appeared. Spraying tends to be less frequent for one year old plants. These plants are usually sprayed five or six times a year with M-22. As plants get older, the frequency of spraying increases and a stronger solution (Dithane M-45) is commonly used. The strength of the solution varies among growers. Concentrations may range from 1.5 lbs. to 7 lbs. of Dithane per 200 gallons of water. Depending upon their personal preference and observation of their own gardens, some growers choose to mix Sevin, formaldehyde, and Captan in with the M-22, M-45, or Manzate compounds. Small growers generally use a hand-held spraying apparatus and consequently do not usually perform as thorough a job as the mechanized boom type spray units used by larger growers (Figure 5-C).

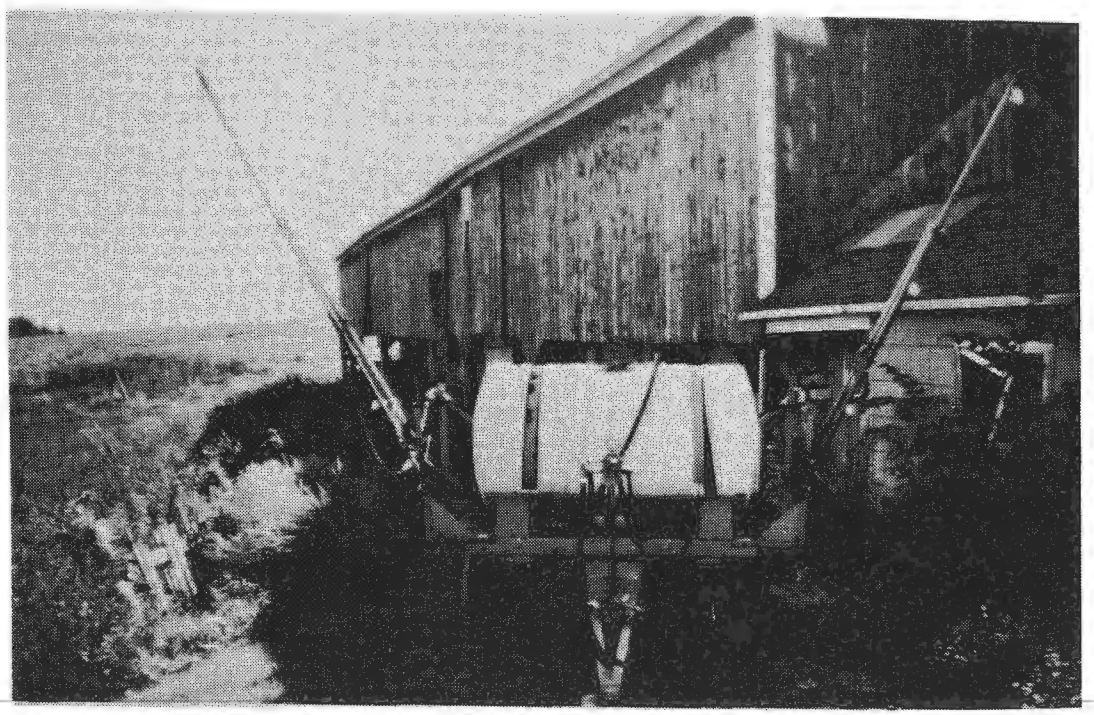


FIGURE 5-C: BOOM SPRAYER IMPLEMENT

The diseases of ginseng can usually be linked directly to the plant's environment. Preventive measures for disease control, other than the use of chemicals, involve changing cultural practices to make environmental conditions less favorable for infections. Development of disease in cultivated ginseng is often related to overcrowding, lack of proper ventilation, and excess moisture in soils either due to inadequate surface or subsurface drainage. Weeding is particularly important in the beginning of the season to eliminate competition from weeds while young seedlings establish themselves. Failure to control weeds will result in increased plant densities, reduced air circulation among plants, and development of conditions favorable for disease. Weeding is an operation performed by hand and is most important among stands of young plants. The leaf area among older plants is much greater, and therefore, tends to shade out weed species. Sanitation is another non-chemical preventive means for control. Severely diseased plants should be destroyed and the infected parts of less severely affected plants removed. Appendix B lists other cultural practices, identifies the more common disease pests in Marathon County, along with suggested control chemicals. "Suggested" is emphasized here; to restate a point made in Chapter 1, "currently, there are no pesticides registered with the EPA for use on ginseng."

Seed Harvest:

Blossoms begin developing on three and four year old plants in late June. All spray operations are curtailed as the flower begins to open. Failure to do this may result in damage to the blossom, interrupt the pollination process, and subsequently affect seed

production. By mid-July fruit formation begins and they are ready for picking by early September after they turn a bright crimson color. The fruit first ripens on the outside of the cluster (Figure 5-D). Because seed harvest is done by hand (Figure 5-E) and is very labor intensive, most growers generally wait until the majority of berries have ripened to eliminate the need for picking twice. Depending on the size of the operation and if time permits, some growers will pick a second time.

Traditionally, after berries have been picked they are placed in burlap sacks (approximately 25-50 lbs. per sack) and are periodically compressed and trampled by foot during a 1-2 week period (similar to crushing grapes to produce wine). At the end of this time, the pulp surrounding the seeds has rotted and is easily separated from the seeds by immersion in water; the pulp and nonviable seeds float while the viable seeds sink. (This is not a totally reliable method, however, in that an air bubble trapped within a viable seed may cause the seed to float and appear nonviable.) After the separation process, seeds are air dried. Drying should only be carried to the point where a handful of seeds can be picked up, squeezed together and upon release they will not stick together. Drying the seeds further can inhibit germination. Frequently, after separation from the pulp, but before drying, many growers will treat the seeds with formaldehyde or other chemical solutions to protect them from fungi. A suggested practice has been to mix one ounce formaldehyde per gallon of water and to soak the seeds in this solution for 20-30 minutes. After they are removed, the seeds are dried without further rinsing.

FIGURE 5-D: FRUIT CLUSTERS OF THE GINSENG PLANT

FIGURE 5-E: SEED HARVEST BY HAND LABOR

A special machine designed to separate seed from the pulp was developed in Canada 10-12 years ago and has been used there since. Within the past three years this machine has been used in Marathon County. Using the machine to separate seed and pulp appears to result in a healthier seed than the crushing and flotation method. This is largely due to shortening the separation process by approximately two weeks which helps reduce problems associated with fly larvae, bacteria and fungi growth, and results in better sanitation with fewer disease control problems.

Seed Statification:

In nature, ginseng seeds have a dormancy period of 18 months or longer before germination occurs. Seeds harvested in a given fall will not grow until the second spring following harvest. Commercial seed is stored in damp sand for a 12 month period before planting in the fall. The common practice of stratifying seeds is illustrated in Figure 5-F. It involves using wood frames generally 10-12' deep with a screen mesh nailed across the bottom to keep out rodents and insects, and to allow free drainage of excess moisture. The frame is filled with alternating layers of sand and seed to within a few inches of the top . After capping the last layer of seeds with two inches of sand, another piece of mesh is nailed across the top. The frames are then stored by stacking them on top of one another in a previously prepared pit. The bottom of this pit is commonly lined with a layer of rock or coarse gravel that is covered by a layer of sand. The pit and frames are covered with a layer of straw after the storage frames have been set in place. Seeds are stratified in this manner to allow air circulation,

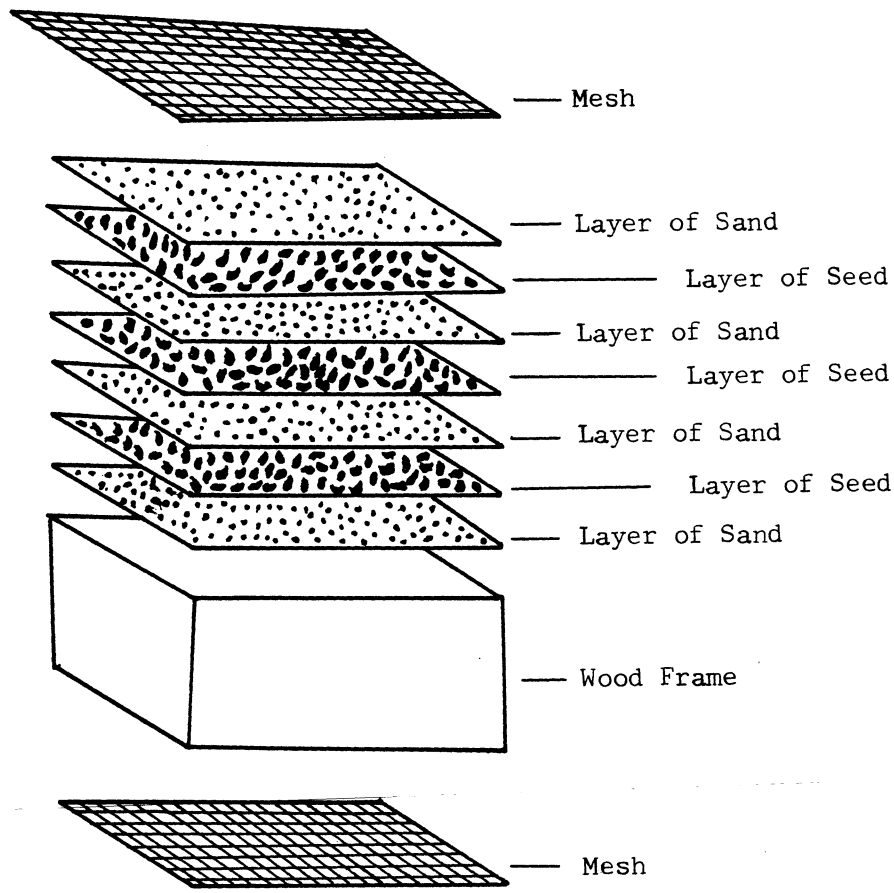


FIGURE 5-F: SEED STRATIFICATION

to keep seeds moist and cool, and to prevent excess moisture from accumulating which results in rotting or mildew formation. Around May growers will frequently remove seeds from storage and examine their overall condition. Before returning the seeds to the stratified frames, many growers will re-float them to remove any additional nonviable seeds and may treat them a second time with formaldehyde according to the method described above.

Seeds are generally removed from stratified storage in August to prepare them for planting. After separating the seeds from the sand, the seeds are placed in open containers and mixed every few days to maintain an even level of moisture throughout. It is a good sign if at this time the seed coats are beginning to crack, but this is not required and it is common for seeds to remain intact until after they are planted. Some growers think that chemicals used to treat seeds before storage inhibit this cracking. Prior to planting, seeds may be given another treatment with formaldehyde, Diazinon, or various other chemicals (Appendix B) to prevent fungus from attacking the seeds once they have been planted. Lewis (1980) suggests soaking seeds for 15 minutes in a 0.25% solution of potassium permanganate or for 5-10 minutes in one part bleach to nine parts water followed by rinsing with clear water. Seeds may also be soaked for 15 minutes using Captan as a disinfectant mixed in a ratio of one tablespoon per gallon of water. Rinsing with water does not follow this treatment.

Seed Bed Preparation:

Many Marathon County growers begin preparing the soil one year in advance of planting. This involves plowing the area in the fall and periodically "quack digging" (Figure 5-G) the area to keep it free of weeds. Many growers fumigate the soil with methyl bromide in an effort to kill insects and potential disease-causing organisms, while others treat the soil with either Diazinon or formaldehyde to accomplish the same purpose. Roy Schwartz, a retired grower, remarked that "if you work the soil well you won't have trouble with grubs or insects. Where the problems with insects occur, is when sod soils are not worked well." (Schwartz, pers. comm.)

Soil fertility is generally not a problem in growing ginseng and while many growers prefer not to use fertilizer a growing number of individuals are experimenting with its use. When commercial fertilizers or barn manures are used, they are generally applied several weeks in advance of planting and thoroughly incorporated into the soil. If animal manures (cattle, sheep, or poultry) are used, special care is needed to select materials that have been stacked for several years and are well composted to avoid injury to ginseng seeds or seedlings and to prevent contaminating the gardens with parasitic organisms. Rate of manure application varies among growers and is known to range up to 5 tons per acre. A caution when using commercial fertilizers is to avoid raising soil pH too high. Growers find that at higher pH levels, a more favorable environment is created for the propagation of disease organisms. Konsler's (1980) research concludes that ginseng does best in soil with a pH of 5.5. Care is also exercised

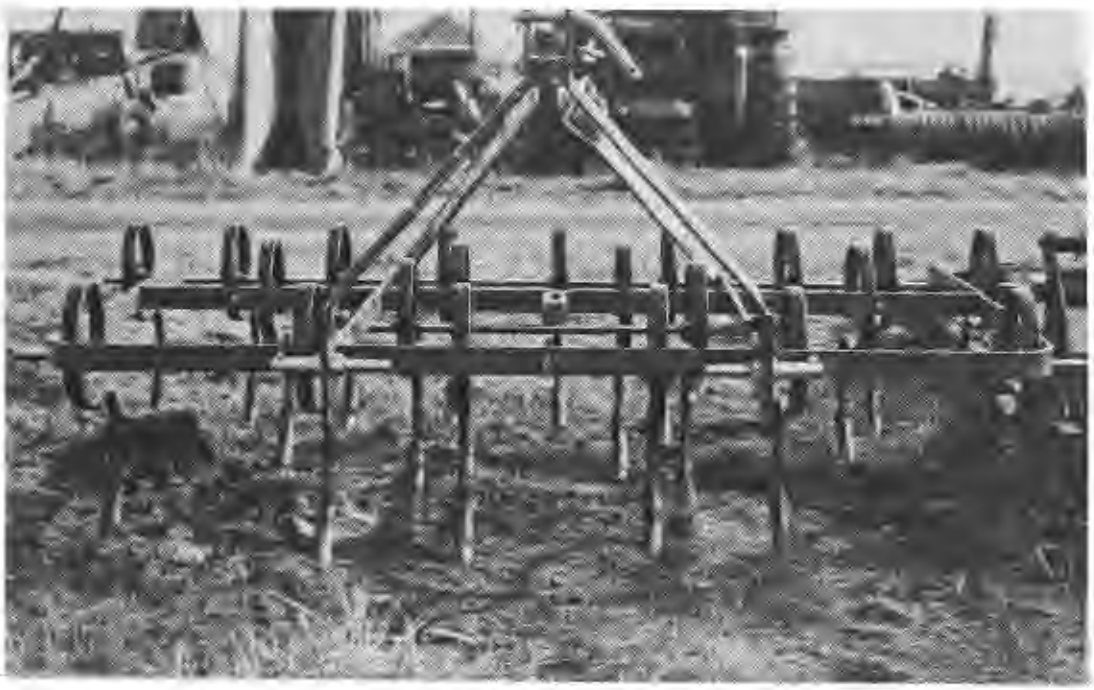


FIGURE 5-G: FIELD CULTIVATOR/ QUACK DIGGER

when fertilizing to avoid increasing the nitrogen content significantly. High levels of nitrogen encourage foliage growth and subsequently limit root growth and development. Soils under natural forest conditions are generally low in nitrogen because it is tied up in the decomposition of plant litter. Those growers that use fertilizers will continue to apply fertilizers at regular intervals throughout the four year growing period. Fertilizers are applied simultaneously while spraying for disease control.

Prior to fall planting, the wood posts and overhead supports which will support the artificial shade for the next four years are installed. Posts supporting the wooden lath canopy are set in a 12'x11'6" grid pattern while posts supporting the black polypropylene fabric are set at 24'x24'4" (Figure 5-H). After post installation, the soil is usually worked up again with a quack digger to loosen the surface layer. This operation is followed by a bed plow (Figure 5-I), an implement that plows and roughly shapes the raised seed bed. As this piece of equipment is pulled across the field a complete bed is formed immediately behind the tractor and half beds are formed on each side. These half beds are completed as the tractor passes along in the next row. The next step involves dragging a "back rake" (Figure 5-J) to loosen the soil, break up large clods, and to pull stones to the surface. The last step before seeding involves using a "bed shaper" (Figure 5-K) that uniformily shapes beds, removing excess soil and filling in depressions. The drainage channels or walkways along each side of the bed are more clearly defined after this operation

FIGURE 5-H: POST SPACINGS FOR ARTIFICIAL SHADE.
TOP - POLYPROPYLENE POST SPACING. BOTTOM - WOOD LATH POST SPACING.

(Figure 5-L). Small operations and growers who do not own or have access to a bed shaper will use a common garden rake to smooth out beds after using a bed plow.

Seeding and Mulching:

Ginseng is planted at a rate of 100-150 lbs. seeds per acre using one of three methods: 1) hand-broadcasting, 2) a small hand garden planter or, 3) a commercial/mechanized planters (Figure 5-M). If seeds are hand-broadcasted, a garden rake is used to cover the seed with a thin layer of soil. After seeding, some growers will spread Mesurol or zinc phosphide baits to control slugs, mice, and other pests before mulch is laid down.

As recently as five year ago it was commonly believed that planting could not occur until after September 1, because prior to this date the warm temperatures maintained a soil environment favorable for fungi and other soil organism activity (Krueger, pers. comm.). However, in the past few years, many growers have successfully begun planting by mid-August. This has the advantage of spreading the labor over a longer period of time.

Oat straw appears to be the mulching material preferred by Marathon County growers. Frequently oat straw is re-threshed, using the familiar threshing machine (Figure 5-N) to remove any grain or weed seeds. This is important because these seeds can attract mice or other rodents, or if they germinate and grow, this will result in extra weeding. Straw mulch is applied either by hand or by mechanical means using rear self-unloading chopper wagons (Figure 5-O), modified manure

FIGURE 5-I: BED PLOW

FIGURE 5-J: BACK RAKE

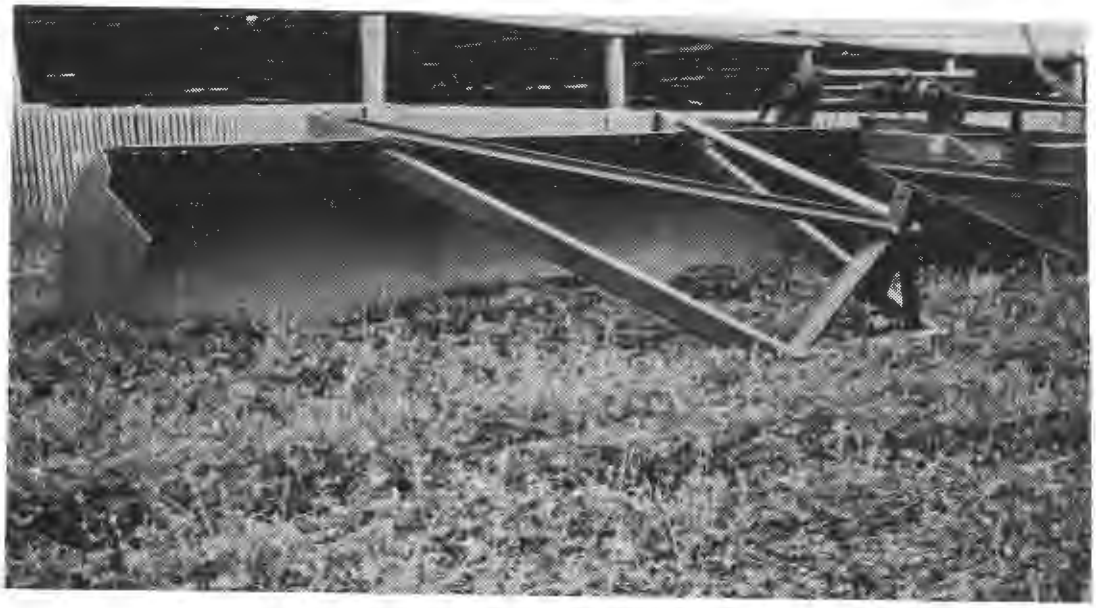


FIGURE 5-K: BED SHAPER

FIGURE 5-L: SEED BED READY FOR PLANTING

spreaders, and other home-built machines. Depending on bale size, 350-750 straw bales are required to spread a 4-5" (uncompacted) layer of straw per acre.

Depending on price and availability of straw, some growers will use hardwood sawdust for mulch. However, there can be problems associated with this practice, because sawdust that is not well decomposed can become compacted and inhibit seedling emergence in the spring. Hsu and Schwartz (pers. comm.) also noted that sawdust retains moisture in the spring which contributes to the problem of damping-off disease.

The use of mulching in ginseng cultivation is important from several perspectives. Perhaps the greatest benefit is protection of the root crown from damage by frost heaving. In spring, mulch prevents soil temperatures from rising too rapidly and delays plant emergence until the threat of a late frost has passed. Mulch also acts as an organic fertilizer that helps to maintain soil humus levels, deter weed growth, retain soil moisture, prevent the leaching of soil nutrients, and has a role in preventing soil erosion.

Root Harvest:

Cultivated ginseng root is typically harvested in the fourth year. Growers may harvest earlier, especially if disease problems are persistent and the possibility of a total loss is anticipated. After the seeding and mulching of new gardens have taken place, the artificial shade is dismantled from gardens to be harvested. Frequently, the growers will scrape off the old mulch and plant material to prevent it from becoming tangled in the harvest equipment and interferring with the collection of roots after digging.

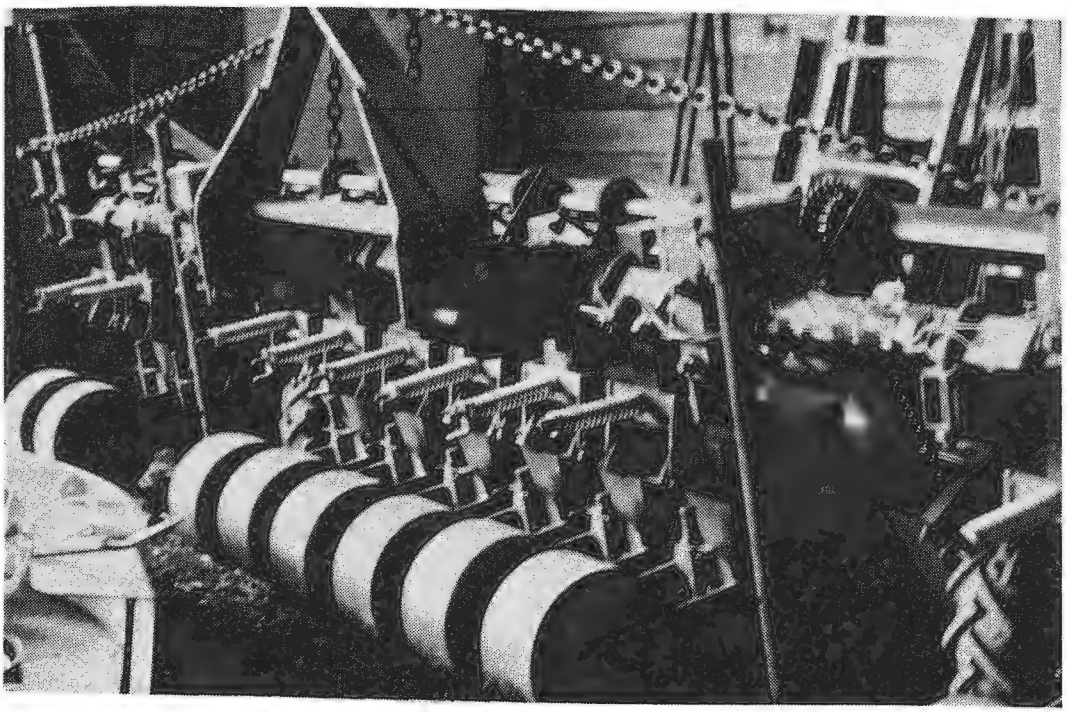


FIGURE 5-M: COMMERCIAL SEED DRILL

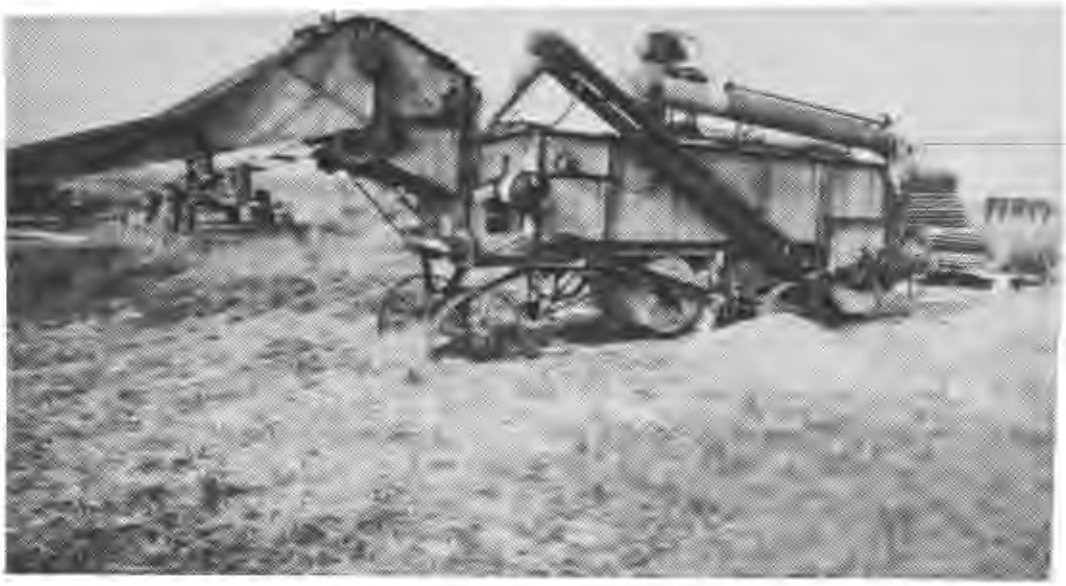


FIGURE 5-N: THRESHING MACHINE

FIGURE 5-0: TOP - MULCH SPREADING IMPLEMENT
BOTTOM - FINAL MULCH COVER

Harvesting generally begins around September 15 and ends in late October. It was once begun earlier than now, because a longer harvest season was required when roots were dug by hand. Today mechanical equipment speeds this process, allowing for a later harvest date and, consequently, additional time for root growth.

Roots are primarily dug with a machine that closely resembles a potato digger (Figure 5-P). The machine deposits the roots on the soil surface, from where they are then hand collected (Figure 5-Q) and placed either in a truck or trailer. Usually the digger passes down the bed twice. After the majority of roots have been picked up, the machine passes the second time to further churn the soil and expose any roots previously missed.

Root Drying:

After digging, roots are washed free of soil in a variety of ways. The most common is to use large volumes of pressurized water (Figure 5-R). Once washed, the roots are transported to a drying site. Drying time varies with root size and drying technique. The most familiar method involves using the wooden lath shade sections as drying racks. Roots are spread out on these inverted sections and sections are stacked to the ceiling in the drying room (Figure 5-S). At the onset of the process, the temperature in the drying room is generally set at 75°F, and is slowly increased each day until 100°F is reached. Depending on the outside temperature and humidity, it usually takes from 10-14 days to complete the drying process. Once the drying process begins, it should be continuous. It is important that drying rooms be designed to have adequate air circulation that evenly

FIGURE 5-P: GINSENG ROOT DIGGER

FIGURE 5-Q: HAND COLLECTION OF ROOTS

FIGURE 5-R: WASHING ROOTS

FIGURE 5-S: DRYING/CURING ROOTS

FIGURE 5-T: SHADE IS STACKED (WOOD LATH) OR ROLLED (POLYPROPLYLENE) TO PREVENT COLLAPSE UNDER THE WEIGHT OF THE SNOW AND ICE

distributes the heat and proper ventilation to remove excess moisture. Roots are dry when they break with a snap. After the roots are dried, they are packed in cardboard barrels and stored in a cool dry area to await shipment.

Marketing:

Most ginseng root is sold between October and December and a sale usually involves the buyer coming directly to the farm. After the roots are inspected a purchase offer is made, and at this time the grower either accepts or declines in anticipation of receiving a higher bid at a later date. The majority of Marathon County ginseng root is exported to Hong Kong and is auctioned off for further distribution to Malaysia, Singapore, Vietnam, and other southeast Asian Countries. The market of mainland China has yet to be developed. The price paid for ginseng root is largely determined by economic conditions of these market areas. If an economy is strong, more money is available for the purchase of root and other commodities as well. Price is also determined by quality and grade of the root being traded. Roots that command the highest price are clean, free of blemishes, and contain no rust or evidence of disease. Color is another factor and can be affected by the method in which the root is dried. The preferred root color is one with a golden tint. Its resemblance to wild root, age, weight, and shape are all factors determining the price of cultivated root. The preference is for short, stubby roots, with some fibrous rootlets extending from the main body, and no prongs. In the Hong Kong market, prongs and fibers extending from the main body are compared with that of fat on meat - some is desireable, but too much is not good (Kong & Hsu, pers. comm.).

According to Tat Kong, New York buyer and exporter, "... ginseng has become a very speculative market; only so much root is available and a relatively small number of buyers are playing the game and potentially at any given time, collaboration among them could easily corner the market and control the price ..."

Investments:

The ginseng grower has a large investment in his crop. Lath shades, seeds, and pesticides are essential. Work in the gardens requires a tractor and other pieces of equipment. Labor costs for weeding, seed harvest, and picking up roots after they have been dug are high because this is largely hand labor. Much energy is required to dry roots properly. Losses to fungi, insects, and diseases can be sudden and catastrophic, especially if it occurs in the third or fourth year. Even if all goes well, the first profit is not realized until at least four years after the initial investment. The estimated costs to produce an acre of ginseng are given in Table 5-A. These figures are based on 1978 prices and should be adjusted to reflect escalating labor, material, and equipment costs, and also to accommodate inflation over the past three years.

Table 5-A: ESTIMATED COSTS TO GROW ONE ACRE OF GINSENG IN MARATHON COUNTY (Jackson, 1978)

Set-Up Costs*

$600 -	One acre of land
$9,000 -	Seed at $60.00 per pound at 150 pounds per acre
$7,500 -	Lumber, including posts, cross pieces, nails
$300 -	Straw to cover crop over 3 year period
$13,100 -	Labor during three-year period: - Planting, 16 hours - Weeding, 3240 hours - Harvesting, 320 hours - Building shelters, 800 hours 4,376 hours of hired help at $3.00 per hour
$2,000 -	Potato digger needed for harvest
$1,000 -	Drying costs at 40 cents per pound
$400 -	Fungicides
$1,000 -	Sprayer for fungicide
$4,000 -	Interest on investment
$500 -	Miscellaneous
$39,400 -	TOTAL

INCOME:

$125,00 -	One acre of Ginseng which produces 2,500 pounds at $50 per pound
$39,400 -	Set-Up Costs
$85,600 -	Net after 4 years

VI. Commons Concerns: Suggested Topics for Future Research

". . . wild and cultivated ginseng produce an annual crop in the United States and Canada values in excess of $25 million dollars, yet there is essentially no research information on this crop . . ."
--Proctor, 1981.

Chapter 1 has recognized that research concerning ginseng cultivation is largely limited by funds and by lack of basic biological knowledge of the plant and its pests. The Literature Review section further acknowledges that some applied studies have been made and others are underway, but growers are still awaiting the results. Much of the soil information contained in reports and feature articles consists largely of few-worded descriptions such as: "mesic to dry-mesic sites", "rich in humus", and "well-drained slopes." Rarely, with the exception of this thesis are soil types mentioned. While it is apparent that Panax quinquefolius occupies a wide variety of sites and soil types, there exists little specific soil information and no compendium of soil characteristics favorable to ginseng cultivation.

It has become readily apparent through this project and from conversations with the most prominent researchers and growers, that as the acreage devoted to the cultivation of ginseng increases, a simultaneous need for research is generated. Stoltz (1981) states that "the cultural information which is available unfortunately is based on folklore and often takes the form of reported interviews with or the opinions of growers or harvesters of ginseng." Most of the states to which ginseng is native have only the sketchiest distributional data and virtually no specific data on soils, associated species, population dynamics, and other pertinent data that could have direct applications to the culture of ginseng.

A recent survey (Curran, 1981) identified many topics of concerns to growers. Although specific details were not given, the top issues ranked by participants according to their importance were: 1) improving root growth; 2) fungicide and pesticide treatment; 3) root drying; 4) seed stratification, and 5) root marketing and harvest. It is not surprising that improving root growth ranked first since this factor has a direct economic impact on the financial return a grower receives on his investment. Paul Hsu, Don Volhard, Rueben Kruger (pers. comm.) and others have indicated their concerns involving research to determine soil fertility and application rates of fertilizers to achieve optimum yields. Perhaps Konsler's (1980) research will provide some of these answers. Other concerns related to yields and of immediate interst to growers include:

1) Root rot disease according to Patty (1976), Hsu (pers. comm.), Proctor (1981), and others have ranked this as the major problem confronting growers. Research is needed to determine what pesticides or other means are effective in the control of this disease.
2) Research directed toward answering the question of how land used to grow one crop of ginseng can be used to grow successive crops.
3) Registration of effective pesticides with the U.S. Environmental Protection Agency for lawful use on ginseng.

Other serious questions which are in need of research are:

1) What are the effects of continued heavy pesticide use (as necessitated by the conditions of the ginseng bed) on: a) the evolution of resistant strains of fungi and insects, and b) the contents and quality of the root product?

2) Can a plant breeding program be used to develop American ginseng strains that are resistant to fungi?

3) What is the effect of increased size and density of ginseng farms on the spread of pathogens?

4) When do the active chemical constituents develop in cultivated roots? What are these constituents? Are they similar or identical to ones found in wild ginseng roots?

The above questions represent major concerns expressed by both growers and researchers. By no means should this list be considered exhaustive. As implied at different intervals throughout this thesis, research is needed at all levels if the cultivation of ginseng is to remain a viable occupation for many individuals, an important export product, and if quality and safety of the root product is to be insured. Probably the most serious problem at present is the extensive, heavy use of available pesticides, with very little knowledge of their efficacy on ginseng pests or effects on roots or the environment.

Another recent concern by growers has developed concurrently with the rapid increase in acreage. Many believe that future root supplies will outstrip the demand and consequently result in a lower return on growers' investments. Robert Corr (1979) along with others agree that new markets for American ginseng need to be developed to insure market stability in price and absorb the increases in future supplies. He acknowledged that the U.S. and mainland China markets are virtually untapped.

In the U.S., the American medical profession once recognized ginseng for its medicinal value and had it listed in the Pharmcopoeia. Ginseng was later removed from this list in 1880 (Marchetti, 1913). Recent investigations seem to indicate that many western authorities are taking a closer look and again may be changing their attitudes about the medicinal constituents of ginseng. It appears that as Americans continue to be more natural food and health conscious, the market for ginseng in the U.S. will increase.

Agricultural trade with the People's Republic of China has been strengthened by the signing of the U.S.-China Trade Agreement in 1979 and again by the U.S.-China Grain Agreement in the Fall of 1980. Perhaps increased trade may contribute to an increase of ginseng trade with China. Especially since China and other eastern cultures have for centuries been firm supporters of ginseng's reputation as a "Panacea", a remedy for the cure of all ills.

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APPENDIX A: AMERICAN GINSENG EXPORTS AND IMPORTS IN PERSPECTIVE

Ginseng, like other marketed crops respond to the law of supply and demand. Escalating prices catch the attention of individuals who are interested in maximizing their profit potential. Tom Karlin (1979) believes that the demand has been keeping up with the production of all growers. However, he feels this may change in the future and result in a supply that exceeds the demand. Since the size of the market is still somewhat limited, the demand for American ginseng must be increased both in this country and on an international wide scale if an oversupply is to be avoided. Competion for the market remains strong among producers and this represents an obstacle for the marketing of increasing American harvests. While Hong Kong remains the primary market for American ginseng,* the United States must compete for this market with the Republic of Korea. South Korea, the world's leading exporter has averaged 1600 tons in 1978 and 1979 (Patty, 1979). Traditionally, Japan has been the largest buyer of Korean ginseng products. Since Japan's pharmaceutical code lists only Asian ginseng, American shipments have been limited to non-medicinal purposes, which in the past has essentially eliminated the United States in the Japanese market (Patty, 1979). However, a change in this trend occurred in 1980 and Japan became a significant market for U.S. ginseng for the first time when over $1 million worth was exported to that country (USDA, 1981). Canada has in the past and continues to remain a sizeable competition for the United States, because that they both produce and export Panax quinquefolium.

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* In 1980, United States exported 245 metric tons to Hong Kong or approximately 83% of the total annual U.S. Harvest for 1980.

New markets including Europe, South America, and the Middle East have recently opened for American ginseng. The People's Republic of China became an American ginseng market for the first time in many years in 1978. But because China is still relatively poor and has little disposable income for luxury commodities, it will probably be a long time before any significant quantities are purchased. The following table places the United States Exports and major markets into perspective.

Table A-A: UNITED STATES: EXPORTS OF ALL TYPES OF GINSENG, AVERAGE 1970-74, ANNUAL 1976-80 (USDA, 1981). (in Metric Tons)

Country of Destination	Average 1970-74	1976	1977	1978	1979	1980
Canada	-	2	3	2 1/	3 1/	2
China						
Mainland	-	-	-	4	3	-
Taiwan	3	1	2	4	3	6
Germany, West	-	-	-	6	8	3
Hong Kong	79	135	153	155	132	245
Japan	-	3	-	-	-	19
Singapore	4	8	12	6	5	4
Other	1	1	3	3	7	14
Total	87	150	173	180	161	293

1/ Estimated. Actual data not available at present time.

In addition to being an exporter of ginseng, the United States also imports a considerable amount of Asian ginseng (Panax ginseng). In 1978, this country imported more than 206 metric tons (crude and advanced forms), compared to the 180 metric tons that were exported.

However, on a value basis, imports of $6.1 million were relatively minor compared with $25 million in exports. These imports have come primarily from the countries in the tables below.

TABLE A-B: UNITED STATES: IMPORTS OF CRUDE GINSENG ROOT BY COUNTRY OF ORIGIN, QUANTITY, AND VALUE - 1978, 1979, and 1980 (USDA, 1979 & March, 1980)

Country of Destination	Quantity (Kg)			Value $$		
	1978	1979	1980	1978	1979	1980
Canada	3,549	3,010	3,076	336,350	385,234	344,499
China, Mainland	10,365	29,425	19,090	70,512	330,134	193,179
Hong Kong	2,443	1,728	2,698	91,425	170,613	372,704
Japan	-	2,187	3,592	-	217,065	558,524
South Korea	62,484	80,333	14,487	2,792,748	7,360,883	296,831
Other	9,601	20,630	7,563	74,567	63,229	128,991
Total	88,442	137,313	50,506	3,365,602	8,527,158	1,894,728

TABLE A-C: UNITED STATES: IMPORTS OF GINSENG IN ADVANCED FORM BY COUNTRY OF ORIGIN, QUANTITY, AND VALUE 1978, 1979, and 1980 (USDA, 1979 & 1981)

Country of Destination	Quantity (Kg)			Value $$		
	1978	1979	1980	1978	1979	1980
	Kilograms	Kilograms	Kilograms	Dollars	Dollars	Dollars
Canada	153	158	734	2,569	10,451	17,221
China						
Mainland	6,356	8,942	32,059	165,697	252,960	743,647
Taiwan	168	1,017	10,786	4,980	9,918	23,972
Germany, West	393	2,037	-	2,894	21,947	-
Hong Kong	43	44	767	2,414	300	64,630
Italy	-	400	102	-	6,600	17,280
Japan	801	505	2,228	82,487	27,298	43,386
Korea, South	109,718	74,979	39,922	2,405,063	2,987,463	2,706,435
Soviet Union	374	2,280	1,000	8,984	8,420	8,067
Total	118,006	90,362	87,598	2,675,088	3,325,357	3,624,638

As can be seen by Tables A-D and A-E, about half (99 metric tons) of the 206 metric tons imported by the United States in 1978 were re-exported. Japan has been the major market for these re-exports, accounting for 87% of the total value.

TABLE A-D: UNITED STATES: RE-EXPORTS OF CRUDE GINSENG ROOT, BY COUNTRY OF DESTINATION, QUANTITY, AND VALUE 1978, 1979, and 1980 (USDA, 1979 & 1981)

Country of Destination	Quantity (Kg)			Value $$		
	1978	1979	1980	1978	1979	1980
	Kilograms	Kilograms	Kilograms	Dollars	Dollars	Dollars
Canada	-	269	639		57,725	102,000
China Mainland	-	133	-	-	20,465	-
Hong Kong	-	227	-		17,945	-
Japan	69,945	40,545	-	1,762,139	2,707,500	-
Singapore	1,680	79	-	66,360	45,119	-
United Kingdom	-	563	-	-	6,410	-
Other	303	-	-	29,173	-	-
Total	71,928	41,816	639	1,857,672	2,855,164	102,000

TABLE A-E: UNITED STATES: RE-EXPORTS OF GINSENG IN ADVANCED FORM BY COUNTRY OF DESTINATION, QUANTITY, AND VALUE - 1978, 1979, and 1980 (USDA, 1979 & 1981)

Country of Destination	Quantity (Kg)	Value ($)
Canada	2,463	68,334
Hong Kong	3,726	101,850
Japan	19,332	520,450
Other	1,994	67,100
Total	27,515	757,734

Table A-E Cont.

Country of Destination	Quantity (Kg) 1979 Kilograms	1980 Kilograms	Value $$ 1979 Dollars	1980 Dollars
Germany, West	2,606	-	190,315	-
Hong Kong	-	5,220	-	436,000
Mexico	1,342	5,493	8,791	66,000
United Kingdon	-	4,990	-	280,000
Other	-	121	-	2,000
Total	3,948	15,824	199,106	784,000

1/ Preliminary.

The future ability of world markets to absorb the larger American harvest will depend on the United States' promotional strategies and the ability to acquire new markets and continue to expand existing ones. One way the United States can increase the volume and the value of its ginseng would be by processing more ginseng here and then exporting larger amounts in advanced forms. While U.S. costs of production are relatively high, every effort should be made to keep them down. Controlling costs and placing more emphasis on research will enable American producers to remain competitive in world markets and discourage other countries from producing American ginseng which would thereby create more competition in an already limited market. Ultimately the future will depend on the political, economic, and social structure of importing countries and whether or not trade sanctions are imposed on or by those countries involved.

APPENDIX B: DESCRIPTION AND SUGGESTED CONTROL MEASURES FOR PANAX QUINQUEFOLIUS L. DISEASES

GINSENG - Diseases

More than a dozen different fungi cause diseases of ginseng in North America. It seems that cultivated ginseng has more problems than wild ginseng with destructive diseases. The reasons for this may be the following: a) Disease may spread more rapidly in cultivated beds because the susceptible plants are close to each other, b) Cultivated ginseng is more closed watched, so diseases that do occur are noticed, c) Cultivated ginseng is often being grown in a foreign or artificial environment, not with its usual associated plants, and under a fertility and watering schedule quite different from wild plants. It is likely that if wild ginseng populations were looked at more closely, many of the same diseases that occur on cultivated ginseng might be observed. Some diseases of ginseng are:

Alternaria blight and root rot. This disease has several symptoms and is caused by a fungus, Alternaria panax. The disease is often first noticed as a leaf spot, however, stem infections, not easily detected may occur in the spring several weeks before leaf spotting. Leaf spots begin as small, water soaked spots which enlarge to reach a diameter of 1/2 inch or more. Where several spots occur on one leaflet, it is often killed. The spots have tan-colored papery looking centers with dark colored borders. Young stems, as they come through the soil are very susceptible to Alternaria infections. Diseased stems have long brown lesions, or dead areas, on the stem near the soil line. These lesions may turn a gray to black color and may enlarge so that the stem becomes girdled, weakening the stem so that the plant

topples over. Leaves of plants having roots rot very slowly. In severe cases, practically every plant in a bed may be affected.

Secondary leaf spot. A fungus called Colletotrichum dematium has been isolated a number of times from specimens brought into UW-Madison's plant disease diagnostic laboratory. This disease is often regarded as a secondary problem in that plants weakened by other diseases or cultural problems are attacked. This fungus attacks leaves and stems of ginseng plants and may cause spotting and blighting of plants as described for Alternaria blight.

Verticillium wilt. Wilt of ginseng can be caused by a fungus called Verticillium albo-atrum. Symptoms include wilting and death of the top of the plant. Infection by this fungus results in a brown or yellow discoloration of the vascular area (water conducting vessels) of the root and stem. This can be observed by cutting through the diseased root or peeling back the "bark" of roots of wilted plants.

White-rot and black rot. Two species of the Sclerotinia fungus cause these decay diseases. White-rot affects roots and stems. Diseased stems lose their green color and become hollow. Infected roots rot rapidly; the tissue becomes soft and brittle. Hard, black bodies (sclerotia) of the fungus form on the outside of the roots and within the stem. Black-rot attacks the roots only. Diseased plants fail to develop in the spring and when roots are dug, they are mummy-like in appearance.

Damping-off. This is a disease of seedlings, caused by a fungus called Rhizoctonia and results in decay of the stem at the surface of the soil. Infected plants fall over and die. Other fungi may also cause seedlings to damp-off.

Papery-leaf spot. This problem is not caused by an infection of ginseng by a fungus or other organism. Common during dry periods, this problem appears as spots between the veins or as burning along leaf margins. This drying is a response to an insufficient supply of water.

Other disease problems include Ramularia root rot or "rust" and Thielaviopsis root rot which are favored by alkaline soils. Phytophthora mildew and root rot, and root knot, a nemotade problem may also cause losses.

Control of ginseng diseases. Disease control measures involve changing cultural practices to make environmental conditions less favorable for infection. Development of disease in cultivated ginseng is often related to overcrowding, lack of proper ventilation, and excess moisture in the soil. Errors in fertilizing and soil treatment may also lower resistance to diseases.

A list of pesticides suggested for control of ginseng pests and diseases have been prepared by University of Wisconsin-Madison researchers C. F. Koval and C. R. Grau and is found on succeeding pages. In addition to chemical control means, the following cultural practices may aid in control of ginseng diseases:

1) Select a site with good air circulation; leaf spot diseases are favored by high humidity.

2) Select a site with good soil drainage; root rots and damping-off more frequently occur in wet soils.
3) Disinfect, steam, or fumigate beds before using to rid the soil of disease-causing organisms.
4) Use healthy plants or seeds.
5) Handle roots with care; injuries can provide a place for decay fungi to enter the plant.
6) Remove and destroy diseased tops of plants during the season and in the fall.
7) Remove and destroy diseased roots of plants infected with Verticillium wilt.
8) Avoid the use of wood ash or lime on the soil where Thielaviopsis or Ramularia root rots may be a problem.
9) Use cultural practices that will promote vigorous growth.

Suggested Ginseng Pest Control Guide
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The materials listed have demonstrated efficacy against the pest problems indicated on ginseng or other crops. However, none are presently registered for use on ginseng. Therefore, the grower assumes all responsibility for such use.

Pest	Effective Materials	Comments
Ants	Diazinon Dursban	Incorporate pre-plant. Granules suggested established plantings.
Aphids - foliar	Diazinon Orthene Malathion Pirimor Temik	Examine leaf undersides frequently. Treat as needed.
Aphids - roots	Diazinon	Use a large quantities of water (400-600 gallons/acre).
Leafhoppers	Diazinon Sevin Methorychlor	As needed - watch for population build-up at alfalfa harvest.
Mice	Zinc phosphide treated grain or apple slices Vacor	
Lygus bugs	Diazinon Sevin Methoxychlor	Treat if 1 or more per 10 feet of plant bed.
Scale	Diazinon Orthene Methoxychlor	When crawlers are active.
Seed Treatment	Heptachlor Chlordane Diazinon	Seeds should be treated at each handling.
Slugs	Mesurol	Spread bait as needed.

Control of Ginseng Diseases

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Cultivated ginseng has several diseases that can limit production, and most likely there are other diseases we have not yet recognized. A better assessment of the major ginseng disease is needed in order to formulate control strategies. Information is needed concerning the life cycles of the pathogens involved with ginseng. This information could be used to find a "weak link" in the pathogen's life cycle where control strategies could be directed. Cultural practices and the use of pesticides could be combined to achieve effective disease control at a lower cost.

Currently, there are no registered pesticides for use on ginseng. However, select pesticides do control some of the known ginseng diseases. Below is a discussion of pesticides that have potential use for control of ginseng diseases. The materials listed are considered candidates for testing to achieve future registration on ginseng.

Alternaria Leaf and Stem Blight

Alternaria blight can defoliate plants, thus, reducing root growth and possibly render the roots more susceptible to root rot. Fungicides that control Alternaria blight are:

Bravo 6F	2-3 pints/100 gal water
Dithane M-45	1.5-2.0 lbs/100 gal water
Dithane M-22	1.5-2.0 lbs/100 gal water
Manzate-200	1.5-2.0 lbs/100 gal water

These fungicides should be applied until run-off. Efforts are needed to evaluate rates and applications procedures and timing of applications for these fungicides.

Root Rot and Nematodes

Root rot is a very serious problem. Root rot reduces yield and quality and apparently is a major component of the replant problem. A fungus call Ramularia is one cause of the root rot ("rust") problem. Other fungi may also be involved. Very little information is available on how this fungus survives and factors associated with its disease-causing capabilities.

Root-knot nematodes have been found in several ginseng gardens. Symptoms of root-knot are the formation of galls on lateral roots and root forking. The amount of damage caused by root-knot nematodes is not known. However, they are very possibly reducing root weight and making the roots more susceptible to root rotting fungi.

Host resistance and cultural practices to control root rot are not known. Chemical control appears to be effective, but information is needed to obtain registration of effective products for ginseng.

Soil fumigation with methyl bromide + chloropicrin may be an effective root rot control. Fumigation is costly and the products used are potentially hazardous to applicators. However, fumigants can not only control root rot, but also control nematodes, soil insects, and weeds.

Soil fumigants to consider for evaluation are:

Terro-O-Gel 67 (67% methyl bromide + 30% chloropicrin)

Dowfume MC-2 (98% methyl bromide + 2% chloropicrin)

Dowfume MC-33 (66% methyl bromide + 33% chloropicrin)

Pesticides for the control of nematodes only:

Hemacur 15G	40 lb/A broadcast
Vydate L Vapam Vorlex	Preplant soil incorporation - 3 to 10 gallons Vydate L in minimum of 20 gals of water per acre. Incorporate to a depth of 4 to 8 inches immediately after application.
Vydate L	Foliar treatment - 2 to 8 pints of Vydate L per 100 gallons of water on a 2 to 3 week schedule for 4 applications. Apply first spray at first full leaf.

The prevalence and severity of the root-knot nematode needs to be established before extensively evaluating these nematocides.

Seed Treatment for Disease Control

Soil fungi can cause seed rot and seedling blight of ginseng. Treatment of the seed with fungicides can control these seed and seedling-attacking fungi. Formalin has been used for many years as an effective seed treatment. Two pints of 40% formaline is added to 24 gallons of water. Into this solution is dipped 135-150 lbs of stratified seed for 30 minutes. It is not known whether this treatment is safe for non-stratified seed. There are many fungicides used as seed treatments of other crops. Below are candidates for evaluation.

1. Dexon 70% WP - 4 oz/100 lb seed
2. Captan (many formulations - rates adjusted according to formulations)
3. Vitavax-200 - 2 oz/100 lb seed

APPENDIX C: SOIL DESCRIPTIONS

(Marathon County Soil Conservation Service, August 1980)

Marathon Silt Loam:

Marathon silt loam is a gently sloping, well drained soil which occurs on convex hill tops on uplands. Most areas of this soil are irregular in shape and range from 4 to 320 acres in size. Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsurface layer is mostly brown silt loam about 11 inches thick and is mostly dark brown silt loam in the upper part; mostly dark brown very gravelly sandy loam in the middle; and multicolored very gravelly loamy sand in the lower part. The substratum, to a depth of about 60 inches, is strong brown gravel. In some places the silty deposits are less than 15 or can be more than 30 inches thick. The substratum may be either a gravelly loam or gravelly sandy loam texture.

Water and air move through Marathon silt loams at a moderate or moderately rapid rate in the subsoil and at a rapid rate in the substratum. Surface runoff from cultivated areas is medium and the available water holding capacity is moderate. The organic matter content of the surface layer is moderately low to moderate.

Many areas of this soil are farmed. Other areas are used for pastureland, woodland, or a source of gravel and roadfill commonly known as rotten granite. This soil, although subject to water erosion is suited for growing corn and small grains, and for grasses and legumes in rotational hay and pasture. Contour farming, stripcropping, contour stripcropping, terraces, diversions, and conservation tillage will reduce soil loss. When Marathon silt loams are used for rotational hay or pasture, water erosion is effectively controlled. Proper management of crop residues and green manure crops will reduce

soil loss, maintain or improve organic matter content, and increase water infiltration. These silt loams when used for growing permanent hay and pasture are an effective way to control soil loss by water erosion. Proper stocking rates, pasture renovation, rotational grazing, and timely deferment of grazing will help keep the pasture and soil in good condition. Marathon silt loams are also suited for growing ginseng. Diversions should be constructed above the ginseng beds to help control erosion.

Fenwood Silt Loam:

Fenwood silt loam is a gently sloping, well drained soil that occurs on sideslopes and on convex hill tops on uplands underlain by igneous and metamorphic bedrock. Most areas of this soil are irregular or long and narrow in shape and range from 10 to 400 acres in size. Surface stones are sometimes common in uncultivated areas.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is mostly brown loam about 10 inches thick. The subsoil is about 25 inches thick and is dark brown loam in the upper part; dark brown loam in the middle; and dark brown cobbly loam in the lower part. Below a depth of about 43 inches, the substratum is fractured igneous and metamorphic bedrock. The surface layer may be typically a loam or sandy loam.

Water and air move through this soil at a moderate rate. Surface runoff from cultivated areas is medium and the available water holding capacity is moderate. The organic matter content of the surface layer

is moderate to high. The depth to bedrock ranges from 42 to 60 inches. Most areas of this soil are farmed while some areas are used for pastureland or woodland.

Fenwood silt loams are suited for growing corn and small grains, and to grasses and legumes for rotational hay and pasture. Contour farming, stripcropping, contour stripcropping, terraces, diversions, and conservation tillage will reduce soil loss. Construction of terraces and diversions can be hindered by the cobbly subsoil and bedrock which can occur at less than 5 feet from the surface. When this soil is used for rotational hay and pasture, water erosion is effectively controlled. Proper management of crop residues and green manure crops will reduce soil loss, maintain or improve organic matter content, and increase water infiltration. These silt loams when used for growing permanent hay and pasture are an effective way to control soil loss by water erosion. Proper stocking rates, pasture renovation, rotational grazing, and timely deferment of grazing will help keep the pasture and soil in good condition. Fenwood silt loams are suited for growing ginseng. Diversions should be constructed above the ginseng beds to help control erosion.

Rozellville Silt Loam:

Rozellville silt loam is a gently sloping well drained soil occurring on convex hilltops on uplands. Most areas of this soil are irregular in shape and range from 10 to 320 acres in size. Most uncultivated areas of this soil have a few surface stones.

Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsoil is about 28 inches thick and is mostly dark brown silt loam in the upper part; dark brown loam in the middle; and yellowish brown loam in the lower part. The substratum, to a depth of about 60 inches, is olive brown gravelly sandy loam. In some places the silty material is 15 to 20 inches thick. The surface layer may be typically a loam or sandy loam.

Water and air move through this soil at a moderate rate. Surface runoff from cultivated areas is medium and the available water holding capacity is moderate. The organic matter content of the surface layer is moderately low to moderate. Most areas of this soil are farmed while other areas are used for pastureland or woodland.

Rozellville soils are suited for growing corn and small grains, and to grasses and legumes for rotational hay and pasture. Contour farming, stripcropping, contour stripcropping, terraces, diversions, and conservation tillage will reduce soil loss. When these soils are used for rotational hay or pasture, water erosion is effectively controlled. Proper management of crop residues and green manure crops will reduce soil loss, maintain or improve organic matter content, and increase water infiltration. Rozellville soils are also suitable for growing permanent hay and pasture. These uses are effective in controlling water erosion. Proper stocking rates, pasture renovation, rotational grazing, and timely deferment of grazing will help keep the pasture and soil in good condition.

Chetek Sandy Loam:

Chetek sandy loam is a gently sloping, somewhat excessively drained soil occurring on convex and concave areas on glacial outwash plains and terraces. Most areas of this soil are irregular in shape and range from 10 to 400 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 8 inches thick. The subsoil is about 15 inches thick and is dark yellowish brown sandy loam in the upper part; dark brown sandy loam in the middle; and brown gravelly loamy sand in the lower part. The substratum, to a depth of about 60 inches, is yellowish brown stratified sand and gravel. In some places the surface layer is loam or loamy sand. The solum may also be more than 24 inches thick.

Water and air move through this soil at a moderately rapid rate. Surface runoff from cultivated areas is slow and the available water holding capacity is low. The organic matter content of the surface layer is moderate. Most areas of this soil are farmed while other areas are in pine plantations.

Chetek soils are suited to growing corn and small grains, and to grasses and legumes for rotational hay and pasture. Contour farming, stripcropping, contour stripcropping, terraces, diversions, and conservation tillage will reduce soil loss. Wind stripcropping, cover crops, conservation tilling, and field windbreaks will reduce soil loss from soil blowing. When Chetek soils are used for rotational hay or pasture, water erosion and soil blowing are effectively controlled. These soils tend to be droughtly during periods of low rainfall because

of the low available water holding capacity. Where an adequate water supply is available irrigation can be used to supplement rainfall. When irrigated, this soil can be suited to growing vegetable crops such as potatoes, sweet corn, and snap beans. Proper management of crop residues and green manure crops will help reduce soil loss, increase organic matter content, and help conserve soil moisture.

Chetek sandy loam are soils suited to growing permanent hay and pasture. These uses are effective in controlling water erosion and soil blowing. However, during periods of low rainfall, yields are reduced because of the low available water holding capacity. Proper stocking rates, pasture renovation, rotational grazing, and timely deferment of grazing will help keep the pasture and soil in good condition.

Moberg Gravelly Loam:

Moberg gravelly loam is an undulating, somewhat excessively drained soil that occurs on hilltops on uplands. Most areas of this soil are irregular in shape and range from 4 to 240 acres in size. Most uncultivated areas of this soil have a few surface stones.

Typically, the surface layer is dark brown gravelly loam about 5 inches thick. The subsoil is about 15 inches thick and is dark yellowish brown gravelly silt loam in the upper part and dark brown gravelly loamy sand in the lower part. The substratum, to a depth of about 60 inches, is yellowish red gravel. In some places the surface layer is gravelly silt loam or gravelly sandy loam.

Water and air move through this soil at a moderate or moderately rapid rate in the upper part of the subsoil and at a rapid rate in the lower part of the subsoil and in the substratum. Surface runoff from cultivated areas is slow. The available water holding capacity is low and the organic matter content of the surface layer is moderately low. Many areas of this soil are farmed while other areas are used for pastureland, woodland, or as a source of gravel and roadfill commonly known as rotten granite.

Moberg soils are suited for growing corn and small grains, and to grasses and legumes for rotational hay and pasture. Contour farming, stripcropping, terraces, diversions, and conservation tillage will reduce soil loss. These soils also tend to be droughty during periods of low rainfall because of its low available water holding capacity. Where an adequate water supply is available, irrigation can be used to supplement rainfall. When Moberg soils are used for rotational hay or pasture, water erosion is effectively controlled. Proper management of crop residues and green manure crops will reduce soil loss, maintain or improve organic matter content, and help conserve soil moisture. Moberg gravelly loam soils are suited to growing ginseng. Diversions should be constructed above the ginseng beds to help control water erosion.

Author's Note: For more specific soils information, the reader is encouraged to contact the Marathon County Soil Conservation Service office located in the Courthouse annex in Wausau, Wisconsin.